Volume 40 • Number 7 • July 1978

Marine Fisheries REVIEW

National Oceanic and Atmospheric Administration • National Marine Fisheries Service

Marine Fisheries Review

Vol. 40, No. 7
July 1978

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Marine Fisheries Review is published monthly by NMFS Scientific Publications Staff, Room 450, 1107 N.E. 45th St., Seattle, WA 98105.

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The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through May 31, 1980.

Managing Editor: W. Hobart

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Price $1.10 (single copy). Subscription price: $12.75 a year, $15.95 a year for foreign mailing. Controlled circulation postage paid at Tacoma, Wash.

MFR PAPER 1312

Charles Woods, Pioneer Scientist on Chemical Composition of Fish

MAURICE E. STANSBY

The first substantial contribution to fishery technology in America was the determination of the proximate chemical composition of most commercially important American species of fish by workers at Wesleyan University, Middletown, Conn., in the laboratory of W. O. Atwater. Today, these results are still the basis for most tabulations in reference works on the protein, fat, and ash content of American food fish. Although the work was conducted nearly a century ago, the analytical work was carried out in a most meticulous way using methods completely compatible with our modern knowledge.

This work has always been attributed to the great American pioneer in agricultural science, W. O. Atwater, under whose sole authorship the results of the work were published. Through the relatively recent availability of correspondence between Atwater and his assistant, Charles Woods[1], it is now apparent that not only the carrying out of most of this work but also much of its planning, as well as the research to adapt analytical methods to analysis of fish, and the writing of the research reports were done by Woods at Wesleyan University during a time when Atwater was on an extended detail to European universities. Much of the credit for this work, therefore, belongs to Woods rather than Atwater. This report documents these facts and includes some of the early background of the then Federal fishery agency which sponsored this research.

In 1871, the first Federal fishery activity began as the U.S. Commission of Fish and Fisheries under the direction of Spencer Fullerton Baird, "In his time perhaps the most representative man of general science in America" (Anonymous, 1920). Baird, without any facilites for carrying out fishery research, set up temporary summer field stations each year at a different locality. In 1878, such a station was established for the year in Gloucester, Mass. (Baird, 1880), and efforts were channeled toward the problems of processing and marketing of fish. For example, Baird interested W. G. Furlow, noted scientist at Harvard University, to look into the causes of red discoloration of salt cod. Within a few weeks, Furlow was able to show that this condition was caused by a microorganism present in the salt, and he prescribed ways for cleaning the salt fish processing plants and then, using uncontaminated salt, to prevent further discoloration (Furlow, 1880).

Noting the complete absence of information on the chemical composition of fish, Baird induced W. O. Atwater, Professor of Chemistry at Wesleyan University, to visit the Gloucester station and interested him in looking into ways that such an investigation might be undertaken. By early 1879, the U.S. Fish Commission had found funding and arranged for Atwater's laboratory to carry out such an investigation. Collection of fish samples took place during 4 years (1879-82) with 80 percent of them being taken in 1881 and 1882. Analyses continued into 1883. Although several progress reports of the work appeared in the Report of the U.S. Commissioner of Fish and Fisheries between 1880 and 1885, the final report was not published until 1892 (Atwater, 1892).

Atwater, in the initial stages of the work, assigned the analyses of the fish samples to seven students, one of whom, Charles D. Woods, began in 1879 while still a senior student at Wesleyan University. Upon his graduation in June 1880, Woods was employed as a full-time assistant to Atwater and thereafter carried out most of the proximate composition analyses of the fish specimens which were completed in 1883. He thus was involved during analyses of nearly 90 percent of such work. During the numerous absences of Atwater from Wesleyan University and especially during Atwater's 15-month stay in Europe, from June 1882 to September 1883, Woods, while acting in charge, conducted a voluminous correspondence with Atwater setting down in considerable detail the activities at Wesleyan University. Thanks to the Cornell University Collection of Regional History and University Archives (footnote 1), this correspondence is available on microfilm. A total of 46 letters from Woods to Atwater and 20 letters from Atwater to Woods are included in these records, and they give an excellent picture in great depth as to the conduct of this early investigation on composition of fish.

WOODS' EARLY LIFE

Charles D. Woods was born in Brooks, Maine, in 1856. He received his early education at schools in Maine and later, in Massachusetts, after his family had moved to Newton, Mass. In 1876 he entered Wesleyan University. Following his graduation from Wesleyan in June 1880, he was employed

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[1]W. O. Atwater Papers, 1876-1892. University Archives, Cornell University, Ithaca, N.Y.

Charles Woods in 1880 when he was beginning his work on proximate composition of fish at Wesleyan University.

by Atwater. As a full-time assistant to Atwater after June 1880, Woods spent much of his time on the fish composition project. Only seven letters from Woods to Atwater covering the period from 1879 to mid-1882 are available to tell us only that he was working on the fish investigation, at first while still a senior as one of several students and later as the only one.

Atwater made a 15-month trip to Europe from 29 June 1882 to about September 1883 (Maynard, 1962). During this trip, he spent several months each in laboratories of noted German investigations in the food science field (such as that of Voit at Munich). During his absence, he left Woods to act in his place. These duties included giving lectures in chemistry, conducting chemical laboratory courses, and continuing research on foods, especially fish composition. The fish investigation at the beginning of this period included determination of the composition of many of the fish samples collected in 1882. When this was completed, the results were tabulated. Where, in some cases, results obtained during earlier stages of the work (often by undergraduate students) appeared not to be in line with those of the majority of similar samples, repeat analyses were made. From the correspondence during this period it was obvious that Woods had not only carried out the regular analyses but had also conducted much corollary research on adapting methods to peculiar problems arising during the fish analysis.

During the period from June 1882 to September 1883, while Atwater was in Europe and Woods was at the critical stage in winding up the work on the fish analysis, he was completely on his own with regard to decisions about which direction the fish project should go. In several instances Atwater did not answer Woods' letters for weeks at a time and when he did, failed to comment on vital issues needing decisions.

Furthermore, Woods failed to receive his salary from Atwater on anything like a regular basis. In his letter to Atwater dated 28 November 1882, Woods writes, "Time moves on and you do not write. It is now some four to five weeks since I have heard from you. I received a letter from Mr. Voorhees in which he said, 'You do not mention Professor Atwater, is he dead?' I do not know how to answer him. I do not suppose an affirmative would be the truth, but my evidence for the negative is slight. But seriously, there are many little matters concerning which I expected answers long ago. I have no instructions from you as regards finance. There are those food and plant bills that I am so weary of . . . As regards the money, my due, I say nothing because you know as well as I do that I have use for it and expected to receive it quarterly and on time. It will very seriously inconvenience me if you do not make an arrangement for paying me at least by January 1."

This matter of recompense for Woods is a key item in the subsequent developments and it is necessary to understand it to see how the completion of the entire project was greatly delayed and how Woods' name never became associated with the research.

Atwater was a member of the faculty at Wesleyan University and as such his salary was paid by the college. He had a budget for his research on foods which he used for many purposes. For the most part, during the period from 1880 when active work on the fish project got fully underway and he hired Woods as an assistant, the salary of Woods came from the grant from the Federal agency sponsoring the work (U.S. Commission of Fish and Fisheries).

When Atwater was away in Europe for the 15-month period, all of the work that Atwater and Woods had previously carried out fell upon Woods. Furthermore, since Woods had no assistant he put in long overtime hours on the fish investigation and he had a verbal agreement with Atwater that he would be paid separately for this overtime on an hourly basis. The quarterly payments for Woods' main salary often did not arrive from the government on time and Atwater kept deferring payment on the overtime for the fish work.

As the end of Atwater's detail to Europe approached during late spring of 1882 the financial picture for Woods became so acute he finally sought other employment. Atwater was unable to give any assurance that Woods' position would extend beyond 30 June 1883, and as it turned out, the support from the U.S. Commission of Fish and Fisheries ceased as of that date. Woods secured an appointment as teacher of science at the Wesleyan Academy at Wilbraham, Mass., in September 1883.

Atwater returned to Wesleyan University at the conclusion of his 15-month sojourn in Germany at the end of September 1883. Upon his return he paid Woods his long overdue regular salary (at a rate of something under $1,000 per year). He had apparently indicated he would pay for the overtime work on the fish project as the work progressed, but later, while still abroad, when pressed by Woods indicated he would settle the matter upon his return from Europe. Yet as late as November 1883, Woods was writing from his new teaching post at Wilbraham requesting payment. The actual amount was only about $100 but at $0.25 per hour as had been agreed, this represented about 400 hours of time. Woods wrote to Atwater from Wilbra-

ham on 5 November 1883: "I have only a minute to remind you that I wrote you a week ago in reference to the money I am due from you. I would like the whole of it ($101.67) or if that is not convenient, I could get along with $50. Hope to hear from you at once as this is of importance to me, for if I cannot have it from you I must raise it elsewhere."

PREPARING FOR PUBLICATION

There is no evidence in subsequent correspondence that this matter was ever resolved. Atwater was unable to prepare the fish work for final publication. He could not do so because much of it was done by Woods while he (Atwater) was in Europe. Yet for reasons unclear from available correspondence, he never paid for the overtime work on this project conducted by Woods.

Atwater tried to get Woods to spend his holiday time at Thanksgiving and Christmas in helping him learn about the fish program. At first Woods had indicated that this might be possible but when it appeared that he was never to be paid for the work that he had done nor was his name to appear as an author on any publication that might result, he put Atwater off with regard to such holiday work. Then on 17 December 1883, he wrote to Atwater: "I have been obliged to change my plans somewhat about Christmas and will not be able to go to Middletown (site of Wesleyan University) as I had expected."

Woods might well have overlooked the failure to pay him for the overtime he spent on the fish composition project if he were to have been promised a junior authorship. On several occasions he wrote suggesting such an arrangement. For example, on 1 October 1883, he wrote to Atwater from Wilbraham saying: "In looking over the notebooks I find that there is a vast amount of material there that I think no one but myself would be able to decipher . . . Now I do not feel like taking the time that is necessary in collecting and arranging this material for the mere pleasure of doing it . . . What I would propose would be we publish it as the work of Professor Atwater and Mr. Woods and everyone would know that you did the brain work and that I did the work in detail, i.e., the analytical work, and it seems to me that that is about the way it was done." Nevertheless, Atwater could not bring himself to agree to such a solution to the problem. Several years passed with nothing being done. Atwater received several critical letters from the U.S. Fish Commission about the long delay in publication of the final research results, research for which they had paid most of the cost.

The deadlock was apparently broken by a letter which Woods wrote on 15 May 1887 from Wilbraham to Atwater which included the following paragraph:

"As regards the old difficulty arising from our investigations, was in hopes that had been finally settled. Wish that you would feel that in that matter, I would be only too glad to help you in any way that you think I can, and that you have but to ask at any time, and I will do all in my power to assist you. If you think that my presence in Middletown would be of the least benefit, I will come if possible. Have been wanting to see you for some time but have not seen it in my way to do so "

Shortly thereafter Woods did go to Middletown and spent a great deal of time in putting together the 189-page final report (Atwater, 1892) which was published in 1892 in the Report of the Commissioner of Fish and Fisheries for 1888.

It is to be noted that Atwater is given as the only author of this report. In consequence, over the intervening years all credit for this work has gone to Atwater, and Woods' connection with it is virtually unknown.

A careful reading of the introduction to the final report, however, comes close to revealing the true situation. Atwater states:

"Although the work has been constantly under my immediate supervision and much of it has been done by myself, the largest part of the details have been skillfully and faithfully performed by my assistants, Messrs. G. P. Merrill, W. H. Jordan, J. H. Long, Miles Beamer, E. B. Vorhees, E. W. Rockwood and especially C. D. Woods. The last-named gentleman has performed the larger portion of the work of the analysis and calculation of the results besides contributing very materially to the elaborating of the methods of analysis and assisting in other ways including the preparation of diagrams and reading of proofs."

Charles Woods at the height of his career as Director of the Maine Agricultural Experiment Station (about 1915).

EXTENT AND IMPORTANCE OF FISH COMPOSITION REPORT

The final report of the Fish composition studies published in 1892 are the most extensive ever undertaken. The main part of the investigation, carried out primarily by Charles Woods, covered proximate analysis (fat, moisture, protein, and ash content) of 53 species of fish and 11 species of mollusks and crustaceans. The 189-page report contains 87 pages of tabular data. The coverage of various species includes most of the ones which are still of major commercial importance in the New England, middle Atlantic, and Great Lakes fisheries. Coverage of species in the south Atlantic and Gulf of Mexico areas is limited and only two species, one tuna and one salmon, are included for Pacific Coast fishes.

It might appear that the analytical chemical methods used in the 1880's would be inadequate and that the results thereby might be of little value today. This is definitely not the case. The method used for determination of ash content was identical to that used today. The methods for fat and moisture were equivalent to present-day practice. These components were determined by drying in an atmosphere of hydrogen (probably superior to modern-day practice of vacuum drying where the vacuum is not always as high as desirable) with fat extraction being carried out with ethyl ether, as is done in modern-day methodology. Protein was determined by multiplying nitrogen content by 6.25 (exactly as is done today) but the nitrogen content was determined for most of the samples by heating with soda ash to release the nitrogen rather than by the modern-day Kjeldahl method. The Kjeldahl method for nitrogen determination was published first in 1883, the year that the analyses of the last of the fish composition samples was completed. However, spot check analyses of many of the samples were later made in Atwater's laboratory by the Kjeldahl method and essentially identical results obtained. By 1889, the Kjeldahl method had replaced the older soda lime method for nitrogen in Atwater's laboratory.

The one serious limitation on the results reported in this paper was the fact that the investigators apparently failed to recognize the fact that there is a very wide variation from one season of the year to another in fat content of the high oil content species. The number of individual fish of each species used in the analyses, ordinarily collected together at one time for this work, usually were not more than five. Accordingly, in the case of the fat types of fish—about eight species (12 percent of the total species analyzed)—the fat content reported would have little meaning.

The values for proximate composition as reported by Atwater in 1892 have been widely quoted and still are to be found in numerous food charts and tables in reference works on the proximate composition of fish.

In addition to the results on fat, moisture, protein, and ash (the work which was carried out largely by Charles Woods), the report contains analyses of both the sulphur and phosphorous content of many of the species. Also, there is a short section of the report dealing with digestibility and calorific value of fish. Although these latter data are limited, they still constitute a large part of what is known on this subject. The work involving determination of digestibility and calorific value was the part of the report in which W. O. Atwater himself was the one actually involved. Some of the work was done in Europe at the time (1882-83) when he visited food laboratories in which such work was underway. Especially the energy value reported was work carried out at Middletown, Conn., after Atwater's return. This work involved use of special calorimeter equipment devised by Atwater.

LATER CAREER OF CHARLES WOODS

Although Charles Woods never received proper credit for his work on the fish composition research, Atwater was instrumental in securing for him the post of Vice Director of the Storrs Connecticut Agricultural Experiment Station in 1888. The Connecticut Agricultural Experiment Station was the first such station established in this country. Woods remained in this position until 1896 and was in close touch with Atwater during this period. The Atwater correspondence shows that their reconciliation was complete. At one time Woods and Atwater spent some time together visiting several European laboratories.

In 1896, Woods was appointed Director of the Maine Agriculture Experiment Station, a position which he held until 1920. He was also Professor of Agriculture at the University of Maine and in 1905 received a Doctor of Science degree from that university. During his long tenure in Maine, he built up the Agriculture Station into a vast empire having research in fields well beyond the limits ordinarily covered in such an activity

During his tenure at Maine, Woods' personality evidently changed markedly from the retiring, diffident attitude he displayed at Wesleyan University under Atwater to a forceful individual apparently somewhat resembling Atwater. Although he left the Maine Agriculture Experiment Station Directorship post in 1920, he is still remembered today as the "Bull of the Woods," as he had been called. He had the reputation of being a "very good" man yet one who was willing, if necessary, to push aside all opposition to his plans in order to attain his objectives.

After leaving Maine he returned in 1920 to Newton, Mass., where his parents still resided and was employed as a Food Information Director at the Massachusetts Agriculture Department. He died in Newton in March 1925.

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MFR Paper 1312. From Marine Fisheries Review, *Vol. 40, No. 7, July 1978. Copies of this paper, in limited numbers, are available from D822, User Services Branch, Environmental Science Information Center, NOAA, Rockville, MD 20852. Copies of* Marine Fisheries Review *are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 for $1.10 each.*

MFR PAPER 1313

The San Diego Tuna Industry and Its Employment Impact on the Local Economy

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INTRODUCTION

Tuna fishing, like agriculture and manufacturing, is a basic industry rather than a dependent one. It brings new money into the community, provides a source of primary employment, and generates secondary economic activity. Tuna has become a staple of the American diet and its market has expanded rapidly. Canned tuna is the nation's leading fish product, constituting more than one-third of the annual pack of all fish and seafood.

San Diego developed early in the American tuna fishery as the main base of the tuna fleet. Although Terminal Island in the Long Beach-Los Angeles Harbor area has dominated the processing side of tuna, San Diego has had at least one cannery for many years. As a basic industry of some consequence, the fishery is well worth consideration in any analysis of San Diego's economic base.

The purpose of this study is to review the San Diego tuna industry. This will include a sectoral and aggregate analysis of its impact on the local economy. This paper has been completed using data up to 1975. Prior to examining the industry, we will briefly focus on the evolution of the tuna industry and its general characteristics in San Diego. This will include a review of the fish fleet, the catch, and the yellowfin quota.

GENERAL HISTORY

The United States tuna industry can be dated from 1903 when a San Pedro sardine packer turned to canning albacore after the local supplies of sardines dwindled. Consumers' acceptance of canned tuna soon led to the development of fishing fleets in both San Diego and San Pedro. Increased public demand for tuna resulted in a growing fleet that ventured progressively further south over time in search of yellowfin and skipjack to supplement the albacore catch. The growth of the fleet has been accompanied by a gradual expansion of support facilities including tuna processing, vessel contruction and repair, and ship chandlery. Tuna processing facilities came to be concentrated at Terminal Island and, much later, in Puerto Rico. San Diego became the major base for the fleet, a position it continues to hold.

The Fleet

Prior to 1957, the San Diego fleet was largely composed of bait boats that fished for tuna with pole and line. Anchovies were used as bait which the vessels caught in coastal waters near the fishing grounds. The development of nylon netting for the purse seine and the Puretic[1] power-operated hauling block revolutionized the industry (McNeeley, 1961). As a result, between 1957 and 1961, most of the vessels underwent conversion from hook-and-line fishing to mechanized purse seining. This markedly increased vessel productivity and reduced typical voyages of 60-90 days to 30-50 days. Consequently, new tuna boats were constructed for the first time in many years. However, the rate of new boat building was relatively slow—approximately a vessel per year through the 1960's. In 1969, the realization of huge profits to be made in tuna fishing led to rapid expansion of the fleet. Not only were many new vessels constructed, but the boats were larger and faster than their predecessors. Whereas in 1969, the San Diego tuna fleet had a total fishhold capacity of 31,750 tons, by 1974 this figure had grown to 52,840 tons. Table 1 depicts the rapid expansion of the San Diego fleet in the Inter-American Tropical Tuna Commission's (IATTC) Yellowfin Regulatory Area (CYRA). The growth in the fleet is reflected more in increased average capacity than in growth in the absolute number of vessels. For the most part, large, new superseiners have been added to the fleet at a rate closely approximating the number of sunken tuna boats and transfers to foreign flags. Consequently, the average capacity of purse seiners increased from 374 tons to 691 tons between 1969 and 1974. In addition, the

[1]Mention of trade names or commercial products or firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

Table 1.—San Diego-based fleet in CYRA[1].

Year	Gear type[2]	No. of vessels	Total carrying capacity	Average capacity
1969	B.B.	36	3682	102
	P.S.	75	28068	374
1970	B.B.	37	3439	93
	P.S.	77	33112	430
1971	B.B.	38	3142	83
	P.S.	78	39782	510
	J.B.	28	508	18
1972	B.B.	40	3933	98
	P.S.	69	36378	527
	J.B.	23	585	25
1973	B.B.	39	4071	104
	P.S.	75	48575	648
	J.B.	4	85	21
1974	B.B.	41	4355	106
	P.S.	70	48381	691
	J.B.	6	104	17

[1]Data from IATTC Annual Reports, 1969-74, and through consultation with scientists from National Marine Fisheries Service, Southwest Fisheries Center, La Jolla, Calif.
[2]B.B. = Bait boat; P.S. = purse seiner; J.B. = jig boat.

San Diego fleet includes about 240 jig boats, although only a few participate in the yellowfin fishery[2].

The Catch

The San Diego high seas tuna fleet[3] directs its fishing effort to the capture of two tropical tuna species, yellowfin and skipjack tuna. These species, which are essentially identical to each other in taste and flavor, constitute most of the "light meat" pack and are taken off the west coast of Central and South America from Mexico to northern Chile. Skipjack tuna caught in these waters usually range between 4 and 7 pounds and are the least valuable of the tunas. This is because their small size makes them more costly for the canneries to process, resulting in the lowest yield of canned product per ton of raw fish. The yellowfin tuna normally accounts for the greatest tonnage. A large fish may weigh as much as 200 pounds although the average size is 25-35 pounds in most years. Valuewise, the yellowfin tuna ranks second to albacore in per unit value.

Albacore is primarily captured by the smaller bait and jig boats, since it is less a school fish than the tropical tunas and cannot be economically pursued by purse seiners. Albacore are normally caught from July through September by the American fishermen along the Pacific Coast of North America. Although the fishing is limited and seasonal, albacore has the highest unit value of the tunas and is the only one legally packed as the "white meat" variety.

Impact of Quota

In response to a growing demand for tuna products, the fishery expanded to the point where it was confronted by the possibility that the basic resource would not support greater levels of exploitation. In 1961, IATTC[4] scientists first expressed concern that tuna seiners, with their vast fishing capacity, would soon overfish the yellowfin tuna stocks and recommended that regulatory action be considered. In 1966, the first restrictive quota on yellowfin tuna was implemented with each member nation responsible for supervising its own fleet in the CYRA.

While a quota system may lead to the conservation of yellowfin tuna through prohibiting fishing for a period of time, it does not solve the problem of excess capacity and fishing power which may continue to grow at a time when stocks are deemed fully exploited. This phenomenon appears to have occurred in the tuna fishery in that fishing capacity has increased substantially since 1966. Although it is not known to what extent the basic resource has been affected since the implementation of the quota system, no such uncertainty exists with respect to the size and capacity of the international fleet. The total fish-carrying capacity of the international fleet has grown from roughly 62,000 tons in 1969 to over 160,000 tons in 1975, which represents an increase of 158 percent in only 6 years.

The rapid expansion of the fleet raises certain questions concerning the factors underlying the dramatic rise in capacity and fishing power. It may be expected that profits were the primary cause leading to this development. However, it is important to know to what extent, if any, the quota system itself may have affected the operation of the fishery.

The major effect of the quota system has been to shorten the fishing season for yellowfin, which in turn has led to the expansion of the fishery to other grounds. It has also resulted in the construction of larger vessels. This is the direct result of a "first-come, first-served" quota system to provide a solution to the allocation problem. In order to maintain its share of the harvest, each participant has had to fish more intensively during the unrestricted yellowfin season. This competiveness has been a contributing factor in the rapid expansion of fleet capacity, as each nation strives to retain its share of the catch. This overcapitalization could lead to severe economic hardship for both vessel owners and fishermen, especially if prices declined in the short run.

The consequences of continued open access to these common property resources will be economic waste and pressure on conservation (Saila and Norton, 1974). As the open season is shortened, this will further add to the cost of fishing, since the fixed cost component of total costs will be spread over fewer fishing days. The magnitude of these costs will also depend on the degree to which fishing is carried on in other areas during the closed season. Many vessels fish in the less productive but unrestricted waters just west of the regulated area and some of the larger tuna boats move to the eastern Atlantic during this period.

Each nation with vessels fishing in the CYRA is responsible for enforcing its own tuna regulations based on the recommendations of the IATTC. However, the United States is the only nation among the IATTC countries that actually patrols to prohibit their own fleet from fishing inside the line after the season has closed. The other countries have no effective systems for monitoring, regulating, and penalizing their tuna boats for violating the rules. The realization of this condition has been partially responsible for the transfer of a number of U.S. vessels to foreign flags so that they would be able to continue to fish "illegally" during the regulated season[5].

[2]This estimate of the number of San Diego jig boats is from the Western Fish Boat Owners Association. The lack of jig boat participation in the yellowfin fishery is due primarily to the long distance to the fishing grounds relative to their limited fish carrying capacity.

[3]The high seas fleet includes those vessels designated as such by the American Tunaboat Association that are over 100 tons in fish carrying capacity and which fish for the tropical tunas in the CYRA.

[4]The Inter-American Tropical Tuna Commission was established for two purposes: 1) To review the biological, ecological, and population dynamics of the tunas and bait species used to catch them in the eastern tropical Pacific in order to ascertain the effects that fishing and natural factors have on their abundance, and 2) to recommend appropriate conservation measures so that fish stocks can be maintained at levels which will afford maximum sustainable yields. While this convention was originally entered into by the United States and Costa Rica in 1950, the commission has since added Panama, Mexico, Canada, Japan, France, Nicaragua, and Ecuador (which withdrew in 1968).

[5]Another factor responsible for flag transfers is the unused special allocations of member IATTC countries, in which additional legal fishing could take place.

SECTOR ANALYSIS

Following a historical perspective of the San Diego tuna industry, we are ready to examine its various components. This analysis will involve a review of each sector and the role it performs in the industry. In analyzing the impact of an industry on a local economy, employment is used as an indicator of growth.

Each sector will be analyzed in terms of employment which is in some way related to tuna. In those cases in which the company is engaged in pursuits besides tuna, only that portion of employment which can be attributed to the existence of the tuna industry will be included. Estimates on tuna-related employment have been made as a result of extensive interviews with various firms, fishermen, union representatives, research institutes and industry spokesmen. This project includes those firms that are directly involved in the accumulation and processing of the commodity, as well as the numerous businesses that participate through manufacturing, supplying and servicing the industry.

Fishermen

Fishermen comprise a significant share of the tuna industry's employment. It is difficult to get an accurate assessment of the number of tuna fishermen in San Diego. This is due in part to the employment practices of some of the vessels who are hiring some resident aliens. In addition, it is usually more profitable for bait boats to pick up crew members from Mexico while enroute to the fishing grounds, since they are paid on a per ton rather than a share basis. Consequently, aspiring local fishermen are having an increasingly difficult time securing employment aboard San Diego based tuna vessels. Such has not been the case for the key men, who are crucial determinants of how successful tuna boats will fare during their fishing expeditions. Since the fishing fleet has been expanding faster than the key personnel, there has developed a shortage of qualified captains, mates, masters, and engineers to fill these important positions.

Another variant inducing fluctuations in fishermen employment is the tuna boats' operating schedules. During the latter part of the year most tuna vessels return to base in order to get refurbished in preparation for the beginning of the open season in January.

Detailed statistical information on the number of commercial fishermen operating out of San Diego County is not available, since some are self-employed and others come into the area only on a seasonal basis. However, it is possible to closely estimate the number of fishermen covered by unemployment insurance[6]. This adjusted figure[7] includes those San Diegans employed on seiners and bait boats, although primarily on the former. A large majority of the fishermen on bait boats are from Mexico. A recently enacted Mexican law stipulates that at least 50 percent of the crew must be of native origin to fish in local waters, which is where the bait boats catch their bait for fishing.

The general industry consensus is that there are about 300 self-employed fishermen who are involved with the jig boat fleet. In addition, there is a fairly large contingent of San Diego fishermen who are employed on Puerto Rico-based vessels, and who are not included in the local unemployment insurance statistics. As the Puerto Rican fleet has expanded rapidly in recent years, so has the number of fishermen (primarily key men) hired from San Diego. A conservative estimate indicates the employment of San Diego resident fishermen aboard Puerto Rican vessels has risen from 250 persons in 1970 to 500 in 1975.

Canneries

There are two major canneries operating in San Diego: Sun Harbor Industries (SHI) and Van Camp. Van Camp's plant is relatively new, whereas SHI (formerly Westgate-California Foods, Inc.) has been operating for a number of years.

Sun Harbor Industries has the capacity to process 275 tons of medium size tuna per day. Unlike other southern California canneries, SHI has relied relatively little on imported tuna. Through 1969, more than 95 percent of her processing included tuna caught by U.S. flag vessels. This figure has recently fallen to between 70 and 80 percent, as the domestic fleet has been unable to fully supply her needs. In 1973, the cannery processed 53,000 tons of tuna of which 17,000 tons were supplied by foreign flag vessels.

Sun Harbor Industries' employment has been remarkably stable. The work force has fluctuated between 650 and 750 while averaging 700 employees over a 200-day annual production schedule that hasn't varied over 10 days in the past 10 years. The cannery's growth is reflected in terms of man-hours per worker. Whereas in 1965 the average employee worked a 6-hour day, this figure increased to 6.5 hours in 1970 and rose to 7.5 hours in 1975[8].

SHI's gradual growth and stability has been augmented by a quintupling of her refrigeration capacity. Since 1973, the cannery's cold storage capacity has increased from 800 to 4,000 tons. This has made it possible for greater stabilization of production schedules along with a reduction in time lost by tuna boats waiting to unload.

Van Camp, a subsidiary of Ralston Purina, completed a $25 million cannery which became operational in June 1976. Due to the magnitude of such a facility, it is pertinent to analyze its economic impact and the reasons for its relocation.

First, we will explore why Van Camp decided to partially abandon its Terminal Island plant in favor of constructing a brand new cannery in San Diego. In order to discover some of the factors involved in this move, interviews were conducted with people from

[6]Preliminary figures are from California Employment Payrolls, Employment Data and Research, Employment Development Department, San Diego, Calif. These figures do not include the self-employed.

[7]Unemployment insurance data were adjusted to account for reporting differences, since a number of tuna boats report employment only when they return with the catch. This tends to distort the annual figures, since in certain months (particularly January and February) the reported employment data considerably understate the number of fishermen who are actually employed.

[8]Sun Harbor Industries' employment trends are analyzed in this study using 7.5 hours as a full working day.

all facets of the industry. Some of the reasons given for Van Camp relocating to San Diego include the following:

1) Present facility very old and in need of extensive refurbishing, 2) very costly to meet Terminal Island's environmental pollution standards, 3) crowded harbor conditions in San Pedro, 4) Terminal Island's lack of space for cannery expansion, 5) majority of fleet based in San Diego, 6) San Diego somewhat closer to fishing grounds, 7) favorable price break on new cannery lease arrangements, 8) less expensive water and utility charges in San Diego, and 9) closer proximity to potentially large supply of tuna from Mexico.

Van Camp's plant has the capacity to process approximately 500 tons of raw tuna daily. Future expansion is possible and its processing capability could be increased to 675 tons per day, which is more than twice the production capacity of Sun Harbor Industries. Like its smaller competitor, the Van Camp facility also produces canned pet food, fish meal, oil, and solubles as by-products. The cannery has cold storage capacity of about 7,000 tons, which should help stabilize production.

It is estimated that upwards of 1,600 persons will be employed in two shifts when the cannery reaches full production. This would include 1,525 employees directly involved in tuna processing along with 75 administrative and office staff positions. In addition, about 100 people are employed in their can manufacturing plant (Daniel, Mann, Johnson, & Mendenhall, 1973).

Although we can closely approximate the number of employees at Van Camp, it is important to estimate the number of jobs that will be created for persons currently residing in San Diego. The number of Van Camp employees who transferred from the Terminal Island facility to the San Diego plant included 164 production workers in addition to 25 administrative and office personnel. This leaves approximately 1,500 positions to be filled by the domestic population including green card workers. The latter presently account for 122 of the 867 current employees. In addition, a number of new service industry jobs will develop in San Diego as a result of the increase in personal income generated by the Van Camp positions.

There is also a small noncommercial processing plant operated by the Mormon church. However, this facility does not sell tuna publicly; it distributes canned tuna to church members who are in need. The cannery "employs" anywhere from 40 to 100 workers who produce between 3,000 and 10,000 cans of tuna daily. The plant's employees who work here in addition to their regular jobs are paid in terms of work receipts, which entitles them to receive free tuna along with other food items from the church if they ever become sick or needy (Anonymous, 1975).

Tuna Boat Building and Repair

The construction and repair of tuna boats is a major component of the tuna industry. Campbell Industries and its subsidiary, San Diego Marine Construction, are recognized for their tuna seiners as well as for their vessel repair and maintenance facilities. In 1970, these two companies entered the superseiner market in earnest when the advantages of fast, efficient, large capacity tuna vessels became apparent. The trend has been toward increasingly larger boats in excess of 1,100 tons capacity with speeds of over 16 knots that are capable of traveling anywhere in the world.

Campbell Industries and San Diego Marine began building superseiners at an increasingly rapid pace between 1970 and 1975. During this period these companies completed 30 tuna vessels, which added 36,400 tons of fish-carrying capacity to fishing fleets in the CYRA. Although the local shipyards were involved in considerable tuna boat building during this period, it was followed by a sharp curtailment in such activity. The slowdown in tuna seiner construction could be attributed to several factors: 1) Realization of overcapacity of the fleet; 2) mounting costs of vessel construction; 3) increased operating costs, especially fuel; and 4) potential cost impact with implementation of 200 mile limit.

It is difficult to assess accurately the employment breakdown between vessel construction and repair. This is due to the high degree of overlap in manpower between these two operations. It is apparent that the emphasis on tuna boat repair and maintenance is greatest during the last 2-3 months of the year, when the boats are preparing for the start of the open season. The initial 9 months of the year would tend to emphasize vessel construction, especially during the beginning of the year when the open season is in progress.

National Steel & Shipbuilding Company (NASSCO) and Harbor Boat & Yacht Company are also involved in the construction and repair of tuna vessels. In recent years, their operations have emphasized the repair and maintenance of seiners and bait boats. The participation of NASSCO and Harbor Boat in this phase of the tuna industry is relatively insignificant compared to that of Campbell Industries and San Diego Marine.

Ship Chandlery

The chandlery phase of the tuna industry supplies the domestic as well as foreign tuna fleets with a broad array of merchandise ranging from paper goods and hardware to netting and compressors. With the exception of locally manufactured fiberglass chase boats and a metal lubricant (WD-40), the numerous chandlery items are produced elsewhere. The three primary ship chandlery firms include: Nuttall-Styris, San Diego Marine Hardware, and Kettenburg Marine. The latter primarily serves the jig and bait boats, while the others supply more than 95 percent of the high-seas tuna fleet.

Ship chandlery activity in San Diego has grown steadily in recent years, due in part to the rapid growth of the tuna fleet. Because of the slowdown in fleet expansion, the chandlery business has leveled off in employment and revenue. The present fleet will likely require sufficient service so as not to warrant a reduction in employment.

Seine Skiffs

The seine skiff, which rests on the stern of the seiner, is used to set the ¾-mile-long purse seine. Mauricio & Sons of San Diego is recognized worldwide for their manufacture of

these skiffs. More than 270 of the craft are being used by foreign tuna fleets. Approximately half of the company's employment involves the building and repair of seine skiffs.

Electronic Equipment

The electronics field has had a major impact on the tuna industry since innovations have accompanied the rapid expansion of the fleet. Improved radio comminications equipment, radar, and depth sounders have done much to increase the efficiency of tuna vessels through enhancing inter-vessel communication and in locating schools of fish. Satellite navigation receivers integrated with on-board computers is the latest electronic device utilized in improving the efficiency of purse seiners.

There are approximately 12 firms involved in this sector of the industry. Marine Electric, the largest company, engages in the sales, installation, and repair of electronic equipment for about 95 percent of the superseiners and a few of the bait boats. The firm's employment has increased steadily with the tremendous expansion in fleet capacity, since each new purse seiner utilizes about $150,000 worth of electronic equipment.

Customhouse Brokers

Shreve and Hayes was the only customhouse broker in the San Diego area until Barbara Olson, Inc. recently entered the field. The broker's duties involve vessel documentation and the preparation of custom papers for tuna boats upon returning to port. In addition, Shreve and Hayes supplies the fleet with tax-free cigarettes and liquor. The whole operation includes only a small contingent of workers who handle steamers and freighters as well as tuna boats.

Marine Insurance

The marine underwriter's insurance business has been a declining segment of the industry. This is due in large measure to the recent consolidation in the ownership of the fleet. Increased cannery control of the tuna boats has resulted in a gradual decline in the number of insurance brokers needed to service the fleet.

Food

The local tuna fleet secures its food products from a number of different sources. The major supplier of food items is San Diego Famous Market, which serves approximately 60 percent of the high seas fleet. This firm deals exclusively with tuna boats and provides them with a wide array of food and meat products. The average purse seiner requires about $8,000 worth of food items for a 50-day trip. The food supply business is another area utilizing relatively few personnel.

Fuel

Fuel represents the tuna boats' highest operating expense aside from the crew members. Fuel, which more than doubled in price between 1973 and 1975, is supplied by the major oil companies that have set up distribution terminals in and around the Embarcadero and Shelter Island. In addition to supplying tuna vessels, these distributorships supply pleasure craft and commercial boats. Fuel delivery is a highly capital intensive business which requires little in the way of manpower. Only a few office staff, drivers, and personnel to operate the pumps are involved.

Salt

The Western Salt Company supplies the local fleet with two kinds of salt. Bulk salt is delivered by pneumatic unloading trucks, which deposit the commodity directly into the seiner's wells. Standard sack salt is also distributed to the vessels. While tuna boats constitute a relatively large share of Western Salt's business, the company's employment would vary little if the tuna industry ceased to exist. This is due in part to the production process, whereby manpower varies little with respect to changes in output. In addition, the product's numerous uses result in its distribution to many different consumers.

Unloaders

There has been a growing tendency for boat owners to hire unloaders to manage the relatively arduous task of unloading the catch. In earlier days, the tuna boats relied heavily on crew members for this purpose. The unloaders not only service the local tuna boats, but also those in Terminal Island as well, since a large contingent of them are transported there daily by trucks from San Diego. The employment of unloaders has risen rapidly in recent years.

Netters

The netters are individuals hired on a temporary basis to help repair the purse seines when the tuna boats are in port. The work is seasonal—usually at the end of the year when most of the vessels are in the process of getting refurbished. A fairly large number of people, many of whom are former fishermen, participate in mending nets.

Green Card Workers

Green card workers (GCW) are Mexican aliens who have obtained permits to work in the United States. Evolution of their use came about as a result of shortages of domestic workers in certain occupations. They are presently occupying some industry positions at a time when domestic unemployment is about 10 percent.

Green card workers are most prevalent within the cannery operations, in which they account for approximately 20 percent of the labor force. The participation of GCW as fishermen is limited, although there are a considerable number of Mexican nationals in the bait boat fleet due to the recently enacted Mexican law.

There are few green card workers in tuna boat construction and repair. This is because most of the shipyards' positions require a minimum level of competency which is usually attained through vocational training not available to the GCW. Although GCW involvement in the rest of the tuna industry is only nominal, their presence as cannery workers alone influences the composition of local employment in the industry.

AN INDUSTRY ANALYSIS

Following an analysis of the various sectors of the tuna industry, it is imperative that we examine the industry as a whole. Throughout this study, employment has served as a proxy for

Table 2.—San Diego tuna industry employment estimates, 1965-75[1].

Sector	1965	1970	1971	1972	1973	1974	1975
Cannery	560	607	620	640	660	680	700
Customhouse brokers	5	6	6	6	6	6	7
Electronic equipment	12	17	20	23	28	32	34
Fishermen	1,176	1,360	1,351	1,358	1,545	1,633	1,685
Food	8	8	8	9	9	12	12
Fuel	9	10	11	12	13	14	15
Marine insurance	10	10	9	8	7	6	5
Misc. supplies and services	N.A.	39	40	42	47	49	55
Netters	10	10	11	12	13	14	15
Salt	3	3	3	3	4	4	4
Ship chandlery	N.A.	70	72	75	78	81	83
Skiffs	13	13	14	17	20	23	26
Tuna boat building repair and maintenance	N.A.	1,509	1,721	1,303	1,749	1,404	1,619
Unloaders	6	30	40	50	60	70	80
Total tuna-related employment		3,692	4,126	3,558	4,239	4,028	4,351
County employment	272,100	387,100	398,000	421,900	451,400	464,700	469,500
Tuna-related employment / S.D. County employment		0.95%	1.04%	0.84%	0.94%	0.87%	0.93%

[1]Estimates herein on tuna-related employment trends are based on extensive interviews with company representatives and industry spokesmen.

Table 3.—Tuna-related employment, tuna landings, and fish carrying capacity[1].

Year	San Diego employment	International fleet capacity (tons)	San Diego fleet capacity (tons)	San Diego tuna landings (tons)
1969	—	62,197	31,750	30,556
1970	3692	72,176	36,551	34,557
1971	4126	95,297	43,432	32,061
1972	3558	115,637	40,886	35,720
1973	4239	136,958	52,731	31,533
1974	4028	152,508	52,840	36,364
1975	4351	—	—	—

[1]Fleet capacity data obtained from scientists of the National Marine Fisheries Service, Southwest Fisheries Center, La Jolla, Calif. San Diego tuna landings data were received through consultation with Leo Pinkas, Department of Fish and Game, Terminal Island, Calif., and from Fish Bulletin 161, The Resources Agency, Department of Fish and Game, California Marine Fish Landings for 1972, Marine Resources Region, 1972.

growth in the tuna business, inasmuch as revenue figures were unavailable. The employment trends in the various phases of the industry are depicted in Table 2. From this table we can make several observations: 1) There was growth in tuna-related employment from 1970 to 1975; 2) approximately 90 percent of the industry's employment is concentrated in three major sectors (tuna boat building and repair, cannery workers, and fishermen); 3) employment has been steadily increasing in all major sectors except vessel construction and repair, which has fluctuated considerably; and 4) while tuna-related employment has been increasing, it remains relatively insignificant compared to total county employment—amounting to slightly less than 1 percent.

It is important to examine those factors which may have contributed to employment growth in the tuna industry. Table 3 includes annual data in tuna-related employment, tuna landings, and the fish carrying capacities of the San Diego and International fleets within the CYRA.

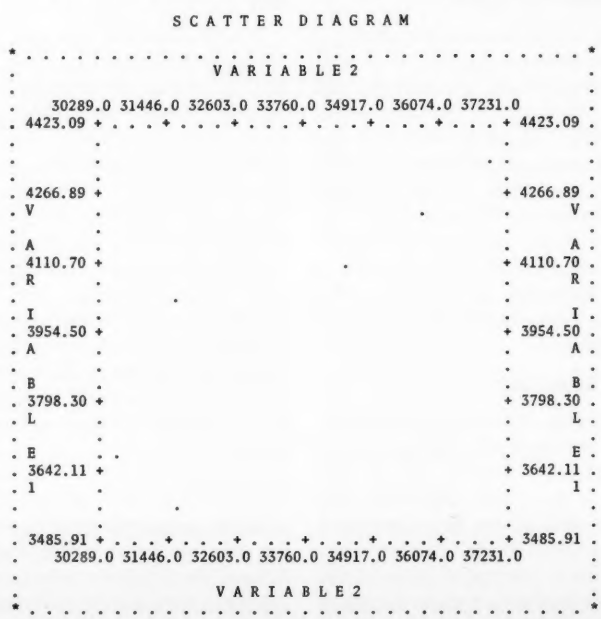
The regression of employment (E) on tuna landings (TL), lagged one year, yields the following linear equation which is depicted in Figure 1:

$$E_t = 536 + 0.103\ TL_{t-1} \quad (3.158)$$

$$SEE = 86.74$$
$$R = 0.845$$
$$R^2 = 0.714$$

The results indicate that the correlation is significant at 5 percent but not at the 2 percent level. Therefore, tuna landings have some impact on tuna-related employment. The equation indicates that if tuna landings increase by 10 tons then employment will rise by an average of one person. Consequently, employment in the San Diego tuna industry stands to benefit from an increase in tuna landings through adding more cannery facilities, such as the new Van Camp plant. However, since the yellowfin catch has reached the estimated maximum sustainable yield in the CYRA, the need for additional cannery facilities in the industry as a whole will depend largely on increases in the

Figure 1.—Employment (Variable 1) and tuna landings (Variable 2).



skipjack catch. Therefore, employment gains in the local economy due to additional processing capacity may be partially offset by losses in other regions.

It is pertinent to measure the tuna industry's ability to generate employment or growth in other sectors of the economy. Using a San Diego County input-output model, employment multipliers were derived to estimate the number of jobs created in other sectors of the economy due to the existence of the local fishing industry (Copely International Corporation, 1976).

The employment multipliers of the major components of the fishing industry are as follows: Vessel construction, 1.206; canneries, 1.391; fisherman, 1.594. For the remaining sectors an employment multiplier of 1.4 is used as an estimate. The direct and indirect employment generated by the San Diego tuna industry is approximately 8,260. This estimated employment figure includes the 1,511 positions created by the Van Camp cannery as well as 665 additional jobs generated in other industries by the new facility.

FLEET CAPACITY

The rapid expansion of the international fleet in the CYRA in recent years has reduced the length of the open season, since the quota has been reached earlier despite its gradual increase. Table 4 manifests the relationship between international fleet capacity, the quota, and the length of the open season.

Since catch per standard day's fishing is greatest during the nonregulated season, as the open season is reduced a larger portion of the year involves regulated fishing. During the closed season, fishing is less efficient since operating outside of the line for yellowfin tuna or inside of it for skipjack tuna is more costly in terms of both time and vessel expense.

It is evident that if fleet capacity is reduced, the open season would be lengthened, and the tuna could be captured by a smaller fleet over a greater period of time. This would reduce economic waste manifested through costs incurred in excessive vessel construction and operation. In addition, it would tend to bring the resource to the canneries in a more even fashion, thereby decreasing tuna losses due to refrigeration as well as lessening unloading time. However, as long as a "first-come, first-served" quota system exists, there is little likelihood of a reduction in fleet capacity.

Table 4.—International fleet capacity, the quota, and the length of the open season[1].

Year	International fleet capacity (tons)	Quota (tons)	Length of open season (days)
1966	46,096	79,300	243
1967	45,973	84,500	175
1968	57,787	106,000	170
1969	62,219	120,000	106
1970	72,613	120,000	82
1971	95,229	120,000	99
1972	115,737	140,000	65
1973	138,152	160,000	67
1974	152,618	175,000	77
1975	169,300	175,000	72

[1]IATTC Annual Reports, 1966-74.

SUMMARY

The San Diego tuna industry represents an important entity in the local economy. It provides jobs not only in the catching of fish, but also in tuna boat building and repair, canning, and in the manufacture and distribution of numerous supplies and services.

The local tuna industry has grown steadily in recent years, as manifested by its overall increase in employment. However, when viewed within the context of the local economy, it accounts for a relatively small share of industrial activity. Although its size in terms of employment is insignificant, if revenue data were available, it is likely that the relative importance of the San Diego tuna industry would be somewhat magnified.

In the near future, the tuna industry's employment can be expected to stabilize, as the catch of the tuna resource appears on the verge of reaching its maximum sustainable yield. This study's analytical results indicate that growth in local tuna-related employment would occur through an expansion in tuna landings, which can be brought about by augmenting local processing capacity.

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MFR PAPER 1314

Portunus spinimanus Latreille, a Portunid Crab With Resource Potential in the U.S. Virgin Islands

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ABSTRACT—An initial investigation into the resource potential of Portunus spinimanus *in the U.S. Virgin Islands is reported. The crabs appear to be widely distributed and are caught best in wire fish traps that are baited and set for less than a week. Female crabs were smaller than male crabs in carapace width and exhibited a different weight-carapace width relation. Sex ratio changed from 48 percent male to over 91 percent male. Periods of reproductive activity were observed twice throughout the study period.*

Virgin Islands fishery resources currently supply about 60 percent of the local consumption (Dammann, 1969). Almost 90 percent of the reported catch is taken in West Indian fish traps (Olsen, Dammann, and LaPlace, 1975). Despite the introduction of significant technological advances, the total catch has gradually declined in the past 44 years (Dammann, 1969). This decline has not resulted from a decrease in the fishing population which has remained constant over this time period. During this period, deep-water snapper and grouper resources have been opened to exploitation (Brownell and Rainey, 1971) and there have been changes in fishing boat design and power from sail to engines, as well as marketing-related communications.

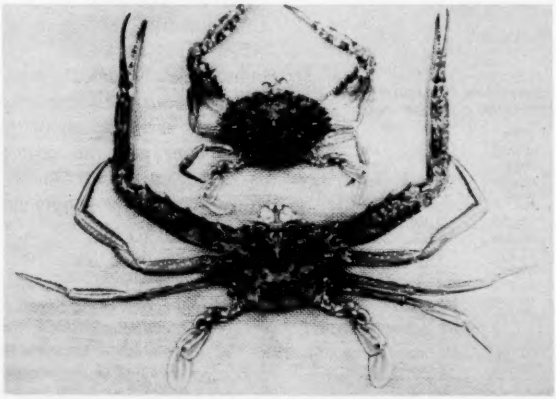
This decrease in total yield is indicative of potential overfishing. As a consequence, local research efforts have centered on the discovery and development of unexploited resources like the snapper and grouper resources on the shelf edge. In 1974, fishermen extension activities led to the discovery of a potential portunid crab resource (later identified as *Portunus spinimanus* Latreille, Fig. 1). The present study represents an initial investigation into the resource potential of *P. spinimanus* in the Virgin Islands.

We undertook exploratory trapping around the shelf to discover the distribution and abundance of the crabs. We investigated the potential market value of the crabs by informal interviews with restaurant and market personnel. We set traps of various designs in one area in an attempt to assess an optimal trap design and soak length. Measurements of weight and length, as well as reproductive state and sex ratio of the samples, were also taken in order to assess annual trends in the population.

MATERIALS AND METHODS

Small (1 m × 1 m × 0.1 m) and regular sized (1.5 m × 1.5 m × 0.5 m) rectangular West Indian fish traps were set in areas on the shelf where interviews with fishermen led us to believe the crabs would be found (Fig. 2). The traps were hauled weekly during the exploratory period. An additional study site was established in July 1975 south

Figure 1.—*Portunus spinimanus* Latreille, is a potential fisheries resource in the Virgin Islands. The male crab (lower) has longer chelipeds (22 mm in this specimen) than the female (upper).



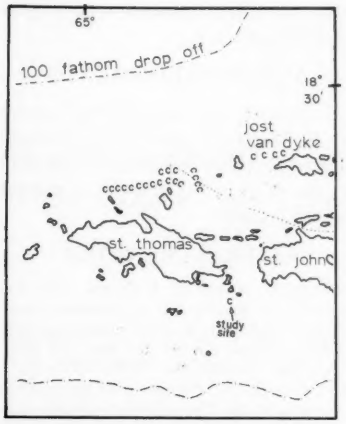


Figure 2.—Map of the Virgin Islands shelf showing the area where *Portunus spinimanus* were caught as a line of c's. The study site is the locale where trap design and soak experiments were carried out.

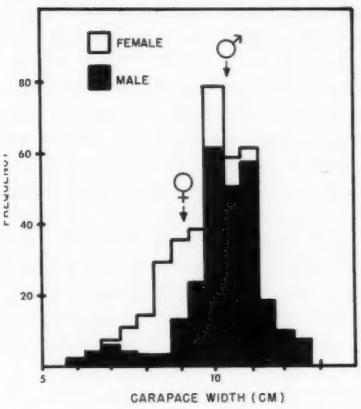


Figure 3.—Size-frequency distribution of *Portunus spinimanus* caught during exploratory fishing. Mean sizes for both sexes are shown by the arrows.

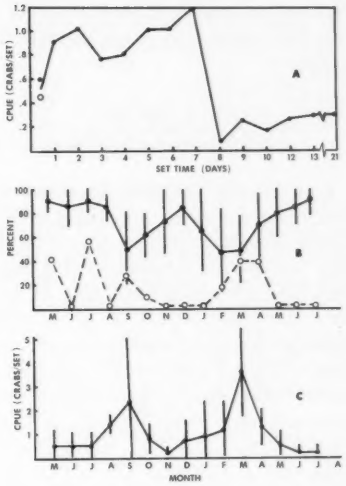


Figure 4.—A. CPUE for *Portunus spinimanus* using a variety of trap designs set for time periods from 12 hours to 21 days. The open circle represents a 12-hour set during daylight hours. Total sample size was 440 sets (average CPU = 1.08 crabs/haul, SD = 0.47). B. Percent of males (closed circles given with one standard deviation) in the samples of *P. spinimanus*. Percent of females bearing eggs is shown by the open circles. Study period was from May 1975 until July 1976. C. CPUE for *P. spinimanus* over the study period is given with one standard deviation.

of St. Thomas (Fig. 2) where traps of varying design were set and hauled at intervals between 16 hours and 22 days to assess trap design and soak length.

All crabs were returned to the laboratory where carapace width was measured to the nearest 0.1 mm and total weight was measured to the nearest gram. Batches of the crabs were given to local restaurants and markets and to individuals in order to obtain an initial estimate of their market value.

RESULTS

The traps were hauled 440 times between May 1975 and July 1976. They caught 474 crabs for an average CPUE of 1.08 crabs per haul (SD = 0.47). The average sized crab had a carapace width of 9.89 cm (SD = 1.21) and weighed 168 g. The size-frequency distribution for the measured catch (Fig. 3) indicates that the females (average carapace width 9.11 cm, SD = 0.88) were smaller than the males (average carapace width 10.3, SD = 1.18).

Regression of weight on carapace width indicated that this relation was different for the sexes. The data were fit to the equation

$$W = aL^b$$

where: W is the weight in grams,

L is the carapace width in centimeters and,

a and b are constants;

with a program in a pocket calculator. The results are given in Table 1. All of the results were significant at the 0.01 percent level or better.

Catch was highest during September 1975 and again in March 1976 (Fig. 4a, b). All of the crabs were caught in depths ranging between 14 and 32 fathoms. Fathometer tracings and sediment on the traps indicated that most of the catch came from a flat sand bottom found offshore from shoal areas.

The sex ratio of the population also changed over the study period (Fig. 4b) from 48 percent male to 91 percent male. Most of the females with eggs were captured from February to May 1976. The smallest berried female measured 7.7 cm carapace width.

The variability between the various fish trap designs tested (Table 2) was significant at the 0.001 percent level (F = 4.83; df = 4,193). The most effective design was the 1 m × 1 m × 0.1 m West Indian fish trap. When set singly it caught almost four times as much as the individual traps when a string of four was set.

Catch was highest when the traps

Table 1.—The constants for the carapace width relation (text equation 1) of *Portunus spinimanus* were different for the two sexes.

Sex	N	*a*	*b*	*r*	*p*
Male	217	0.11	3.19	0.99	<.01
Female	85	0.24	2.02	0.87	<.01
Combined	302	0.12	3.16	0.95	<.01

Table 2.—Analysis of variance of the CPUE for the various trap designs indicated that there was significant variability between designs (F = 4.83; df = 4,193, p < .001). These traps were all set at one site south of St. Thomas. (See Fig. 2.)

Trap design	No. hauls	Total catch	Mean catch	SD
Wire fish traps	20	70	1.53	1.92
String of 4 wire traps	76	75	0.99	1.15
West Indian fish traps	22	15	0.76	1.14
Fish trap (tubular funnel)	69	23	0.37	0.83
Fish trap (net funnel)				
Net funnel crab trap	11	2	0.18	0.23

were set for between 1 and 8 days (Fig. 4a). Thereafter, the catch decreased sharply.

DISCUSSION AND CONCLUSIONS

It is difficult to assess the resource potential of *Portunus spinimanus* in the Virgin Islands at present. Catch rates were low and the variability in the data high. The sources of variability in the data stem in large part from the exploratory-experimental nature of the present study. Traps were moved to different locales frequently except at the study site south of St. Thomas. A variety of traps and set times were employed at this site which also introduced variability in the CPUE.

The results do offer some encouragement. Marketing inquiries indicated a ready market with a possible ex-vessel price of US$1.50 per pound. The fact that we were able to catch in all of the areas in which we fished is also encouraging. Virgin Islands fishermen currently catch 4.7 pounds of fish per set with traps that cost between $50 and $80 and are set 7 days. The cash value of this catch is around US$5.90. The successful traps used in the present study cost around US$20 and caught 0.5 pounds per set and could be hauled three times a week. This catch rate would increase if fishing had been concentrating in several areas. With a higher catch rate, the low investment may indicate that there is potential for development of the resource. An added benefit to the Virgin Islands fishery would be the diversification of effort with consequent reduction of effort on other resources.

ACKNOWLEDGMENTS

This work was supported in part by the PL 88-309 program of the National Marine Fisheries Service, NOAA, and by the Virgin Islands Government matching funds.

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MFR PAPER 1315

Mesh Selectivity of West Indian Fish Traps

DAVID A. OLSEN, ARTHUR E. DAMMANN, and JOSEPH A. LaPLACE

ABSTRACT—West Indian fish traps were constructed from three different sizes of poultry mesh. They were hauled every 6-7 days. The 1-inch hexagonal mesh traps caught 17.9 times more fish than the 1.5-inch hexagonal netting, while the 1- × 2-inch rectangular mesh caught 9.5 times more fish. These fish were almost entirely below market size.

INTRODUCTION

West Indian fish traps are the most frequently used fishing device in the Virgin Islands and most of the Caribbean (Sylvester and Dammann, 1972; Munro, 1974). Over 80 percent of the Virgin Islands fishermen use only fish traps in their fishing despite the fact that more than 10 types of fishing are employed (Olsen, et al., 1975). Pot fishing accounts for over 52 percent of the total inshore fishing in Puerto Rico (Juhl and Suarez-Caabro, 1973). Over 9,000 traps are lost each year in the U.S. Virgin Islands (Olsen, et al., 1975) by theft and boats cutting buoys. Some of these traps remain on the bottom killing many fish until the wire corrodes away. Many persons feel that mortality from "drowned" traps may deleteriously affect the fishery. Another trap-related mortality occurs when unusable fish are brought to the surface, causing embolisms in the physoclists.

Fish traps in the Virgin Islands were originally made from woven hoop vine (*Trichostigma octandrum*) and split bamboo, but are now made from poultry wire (Sylvester and Dammann, 1972). Current regulations only allow mesh that is 1.25 inches or larger in the largest dimension. Generally, 1.5-inch hexagonal mesh is preferred although 1- × 2-inch rectangular mesh is used when 1.5-inch wire is unavailable. Since the smaller meshes may retain juvenile and small forage species which embolize when brought to the surface, we initiated the following experiment in order to determine the optimum mesh size. We hoped to gather information about mesh-related mortality which would be used in the formulation of regulations for the fishery.

MATERIALS AND METHODS

Two rectangular (4 feet × 5 feet × 1.5 feet) fish traps were constructed of each mesh size (1-inch, 1- × 2-inch, and 1.5-inch) and set in an area north of St. Thomas (Fig. 1) where previous fishing indicated the presence of concentrations of small fishes. The traps were left unbaited and were hauled every 6 or 7 days. Munro (1974) has shown that total catch is relatively constant in this time period. The depth ranged from 28 to 32 fathoms.

After each hauling, the catch was returned to shore where the lengths of all fishes were measured to the nearest millimeter.

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RESULTS

The traps were hauled a total of 90 times over 15 weeks and caught 1,559 fishes. Three species, *Lutjanus synagris*, *Rhomboplites aurorubens*, and *Haemulon aurolineatum* made up 96 percent of the catch by numbers. The catch by species for each mesh size is shown in Table 1.

The mesh selectivity was assessed by analysis of variance (ANOVA) of standard lengths of *L. synagris* and *R. aurorubens*. Only 2 of 174 of the other common species, *H. aurolineatum*, were not caught in the 1-inch mesh traps.

The ANOVA results for *L. synagris* (Table 2) indicated that there was significant variability in the standard lengths between the different mesh sizes ($F = 16.6, p<0.001$, df = 2,200). The results for *R. aurorubens* (Table 3) also indicated significant mesh selectivity ($F = 4.14$, $0.01 < p < 0.025$, df = 2,1112).

Attempts at freeing the fish showed that some of the *R. aurorubens* and *H. aurolineatum* could have survived if released after being hauled to the surface. The *L. synagris* would probably not.

Figure 1.—The study site was located north of St. Thomas on the outside edge of Bailors Bank in 28-32 fathoms of water.

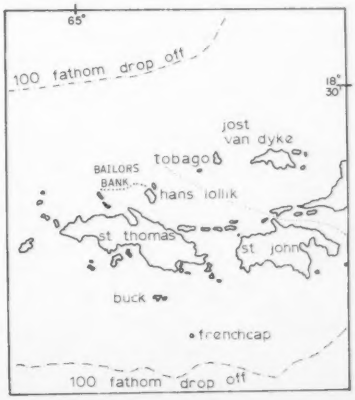

Table 1.—Fish species caught in West Indian fish traps made of different mesh sizes. The results are based on 15 hauls of two traps constructed of each mesh poultry cloth ($N = 30$ for each mesh size). The study period was from 26 May 1975 to 19 September 1975. Mean standard length is given with standard deviation.

	Mesh size								
	1-inch hexagonal			1- × 2-inch rectangular			1.5-inch hexagonal		
Species	*N*	$\bar{X}$	SD	*N*	$\bar{X}$	SD	*N*	$\bar{X}$	SD
Lutjanidae									
Lutjanus synagris	52	15.7	3.6	117	17.4	2.1	34	20.1	3.7
Rhomboplites aurorubens	720	12.4	1.3	379	14.6	1.3	16	15.6	2.8
Priacanthidae									
Priacanthus arenatus	36	9.9	0.8	9	13.3	7.0			
Sparidae									
Archosargus rhomboidalis									
Calamus pennatula	3	14.0	1.0	1	18.0	—			
Pomadasyidae									
Haemulon aurolineatum	172	13.0	0.8	7	14.4	2.6	2	15.5	—
Carangidae									
Caranx fusus				5	43.1	8.7			
Seriola dumerili	1	25.0	—						
Balistidae									
Balistes capriscus	1	14.0	—				3	24.2	7.3
Average for all species	985	12.6	1.3	524	15.5	1.6	55	18.8	3.5

Table 2.—Analysis of variance (ANOVA) of standard lengths of *Lutjanus synagris* caught in West Indian fish traps made with poultry netting of three different mesh sizes.

Mesh	*N*	$\bar{X}$	*F*	*p*	df
1-inch	52	15.7	16.6	<.001	2,200
1-inch × 2-inch	117	17.4			
1.5-inch	34	20.1			

Table 3.—Analysis of variance (ANOVA) of standard lengths of *Rhomboplites aurorubens* caught in West Indian fish traps made with poultry netting of three different mesh sizes.

Mesh	*N*	$\bar{X}$	F	*p*	df
1-inch	720	12.4	4.14	$.01<p<.025$	2,1112
1-inch × 2-inch	379	14.6			
1.5-inch	16	15.6			

DISCUSSION AND CONCLUSIONS

The three mesh sizes currently in use in the U.S. Virgin Islands exhibit considerable selectivity. This selectivity acts in two ways. Within any one species, the smaller mesh sizes retain both the smaller and larger individuals. Since the larger mesh size releases small individuals of species, there is also species selectivity for the larger species.

We do not feel these results indicate differences in fish ingress into the traps. This assumption has been based on many diving observations of traps which contained many small fish which were absent when the traps were hauled to the surface and is supported in part by Munro's (1974) work in Jamaica.

If equal ingress can be assumed, then the 1.0-inch mesh traps killed 17.9 times more fish than the 1.5-inch mesh traps. The 1-inch × 2-inch mesh traps killed 9.5 times more fish than the 1.5-inch mesh traps. This mortality of juvenile and forage species can decimate a fishing ground. If traps are lost ("drowned") it seems possible that considerable mortality could take place over the 1-2 years before the wire mesh corrodes away. This time (for corrosion) is longer for the smaller mesh traps; hence, mortality will be greater.

Currently, Virgin Islands fishermen only use small mesh wire for their traps when the 1.5-inch mesh is unavailable. This choice is largely a matter of cost. The 1.5-inch mesh may be near optimal ecologically and economically since it releases the small species while a larger mesh size would also release marketable fish.

ACKNOWLEDGMENTS

This work was supported in part by the National Marine Fisheries Service PL 88-309 program and the Virgin Islands Department of Conservation and Cultural Affairs.

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MFR PAPER 1316

The Pacific Northwest Commercial Fishery for Sturgeon

NORMAN B. PARKS

The sturgeons represent one of the oldest groups of fishes and have certain structures resembling the sharks, including the inferior mouth supported by jaws, the spiracles, and the heterocercal caudal fin. Sturgeons have no real scales although the body is covered with small, rough, bony plates. They have five rows of prominent bony plates, each with a curved sharp spine, located on the mid-dorsal, mid-lateral, and ventrolateral surfaces. Four prominent barbels are located in a transverse row on the lower surface of the snout (Fig. 1) (Hart, 1973).

Sturgeons are somewhat sluggish and are mostly bottom dwellers. They occur in both fresh and salt water; the marine species enter rivers to spawn (Clemens and Wilby, 1961). It is well known that all species of sturgeon are able to survive in both fresh and salt water, regardless of whether they are anadromous or purely freshwater species (Bajkov, 1951).

Prior to the late 1800's, sturgeons were very common in North American waters, but they were then of little commercial value. Caviar and smoked sturgeon then became popular, causing the prices of these products to rise rapidly. Sturgeon fishing became profitable and, as a result, they were overfished and, in many places, almost exterminated (Bajkov, 1949).

Two species of sturgeon inhabit the waters of the northeastern Pacific Ocean. These are the white sturgeon, *Acipenser transmontanus*, and the green sturgeon, *Acipenser medirostris*. The white sturgeon is larger than the green, having a maximum weight of well over 1,000 pounds (454 kg), and is more desirable as a food fish, bringing a higher price in the market (Fig. 1). Although the white sturgeon has been generally considered an anadromous species, Bajkov (1951) states that many large sturgeon remain in the upper Columbia and Snake Rivers during their entire lives and never go to sea. White sturgeon range from northern California to the Gulf of Alaska (Hart, 1973).

The green sturgeon is an anadromous species and is seldom found above brackish water. It is much smaller, having a maximum weight of about 300 pounds (136 kg) (Fig. 1). It is less abundant and, because the flesh is of inferior quality, has a lower commercial value than the white sturgeon. Green sturgeon range from southern California to the Gulf of Alaska and Unalaska Island (Hart, 1973).

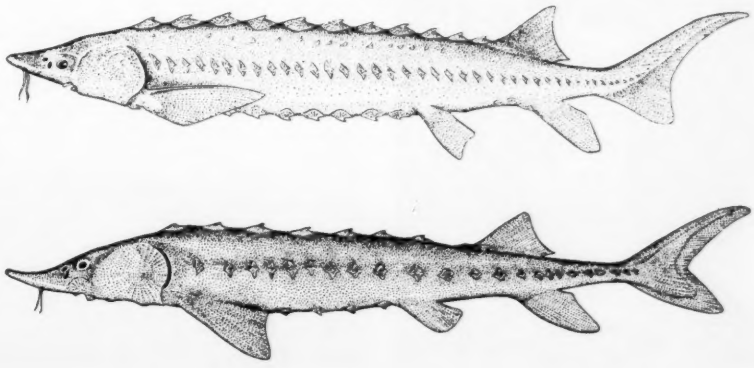
Commercial fisheries for white sturgeon exist in the Columbia and Fraser Rivers. In addition, landings which are primarily incidental to the harvest of Pacific salmon (genus *Oncorhynchus*) are made in several Oregon coastal rivers and in Willapa Bay and Grays Harbor, Wash., as well as in other areas. Most of the catches now are made with salmon nets, although some are taken with large mesh nets or bait-set lines. Green sturgeon are harvested mainly as an incidental species in the gillnet fishery for salmon in the salt or brackish water areas of bays and rivers along the Oregon and Washington coast and in some areas of British Columbia.

HISTORY OF THE FISHERY

Fraser River

Prior to 1880 in the Fraser River, B.C., there was a small Indian subsistence fishery. By 1886, with the development of the salmon fisheries,

Figure 1.—White sturgeon, *Acipenser transmontanus*, top, and green sturgeon, *Acipenser medirostris*, below (after Hart, 1973).



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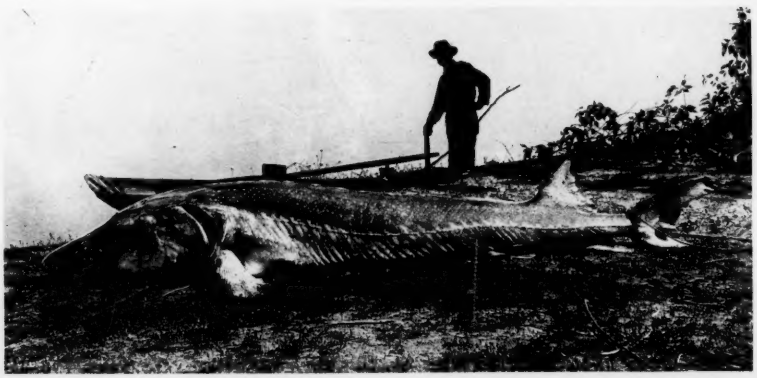
Top, a catch of sturgeon from the Columbia River. The sturgeon at right was taken at Cascade Locks, Oreg. The 1,500-pound specimen below was caught in the Snake River near Payette, Ida. At left is a 900-pound, 11½-foot female take at The Dalles, Oreg. Photos are from files of the Oregon Historical Society, 1230 S. W. Park Avenue, Portland, OR 97205.



there was a growing incidental catch of sturgeon in salmon nets. Local markets for caviar and sturgeon flesh gradually increased, and by 1894 export to eastern markets was underway. The white sturgeon fishery reached a peak just before the turn of the century. The peak catches in 1897 and 1898 of over 1,000,000 pounds (453,515 kg) and of 750,000 pounds (340,136 kg), respectively, were followed by a sharp decline to only 65,000 pounds (29,478 kg) in 1901.

In 1907 the catches began to increase again with 500,000 pounds (226,757 kg) or more being taken in each year from 1909 to 1912. Beginning in 1913 catches again began to decrease, and since 1917 commercial catches have seldom exceeded 50,000 pounds (22,676 kg) (Semakula and Larkin, 1968). The earlier sturgeon fishery from 1880 to 1900 apparently depleted the virgin stock, followed by the remaining small accumulation between 1907 and 1915. Catches during the last 10 years (1965-75) have averaged approximately 26,000 pounds (12,159 kg) per year.

Columbia River

Prior to about 1880, when the white sturgeon fishery was just beginning, this species was apparently extremely abundant in the Columbia River, between Washington and Oregon. The prices paid for dressed fish and for caviar at that time were so low that tremendous numbers of large and small sturgeon were destroyed by the fishermen because the fish had little commercial value and caused considerable damage to the gill nets used by early salmon fishermen (Cleaver, 1951). The sturgeon fishery had its beginning as an important industry on the Columbia River in 1888 when 94 tons of sturgeon were salted and pickled and the first car of frozen sturgeon was shipped east. The advent of freezing methods and the acceptance of smoked sturgeon and of caviar made from the eggs gave the sturgeon new value to the fishermen and resulted in rapid expansion of the fishery. The sturgeon fishery was soon of substantial importance and became second in value to only the salmon (Craig and Hacker, 1940).

Sturgeon were caught with the various types of gear used to capture the salmon—including gill nets, seines, fish wheels, and traps, as well as hook-and-line gear. In 1892, which was only the fourth year of intensive fishing, the sturgeon catch reached its peak on the Columbia River when about 5,500,000 pounds (2,494,331 kg) were landed (Pruter, 1972). Table 1 shows the average annual commercial landings of sturgeon caught in the Columbia River and tributary streams from 1889 to 1975.

The sturgeon fishery held its place as a major part of the commercial fisheries of the Columbia River for only a few years. Immediately thereafter acute depletion of the stock became evident and the high production level could not be maintained. Therefore, the catches declined so that in 1899, after only 10 years of intensive fishing, the total catch was less than 100,000 pounds (45,351 kg) for the river. From that time on, the sturgeon fishery has been merely incidental to the salmon fisheries in the Columbia River (Craig and Hacker, 1940). Depletion was rapid because sturgeon are slow growing and the average weight dropped from 150 pounds (68 kg) at the turn of the century to the present average of about 40 pounds (18 kg)[1]. Catches during the last 10 years (1966-75) have ranged from 176,000 to 527,000 pounds (79,819 to 239,002 kg) and have averaged 357,000 pounds (162,000 kg) annually. During each of the last 3 years (1973-75), catches have increased to over 465,000 pounds (211,000 kg).

Green sturgeon catches were not differentiated in early years but were included in the catches beginning in about 1913. Green sturgeon made up approximately 5, 21, and 22 percent of the total Columbia River sturgeon catch in 1941-50, 1951-60, and 1961-70, respectively.

The average annual commercial landings of sturgeon in Oregon and Washington coastal districts and in Puget Sound are shown in Table 2.

[1]Fish Commission of Oregon 1972. Oregon resource analysis, Columbia River drainage. Fish. Comm. Oreg., Manage. Res. Div., 3 p. Typescript.

Table 1.—Average annual commercial landings, in pounds, of sturgeon caught in the Columbia River and tributary streams, 1889-1975[1].

Years	Avg. annual landings (lb)	Years	Avg. annual landings (lb)
1889-90	2,416,000	1931-35	93,000
1891-92	4,514,000	1936-40	109,000
1895	4,704,000	1941-45	170,000
1899	73,000	1946-50	414,000
1904	138,000	1951-55	320,000
1915[2]	135,000	1956-60	341,000
1923	183,000	1961-65	237,000
1925[3]	231,000	1966-70	269,000
1926-30	181,000	1971-75	445,000

[1]Sources: Pruter (1972) for 1889-1960; Fish Commission of Oregon and Washington Department of Fisheries (1972) for 1961-70; Oregon Department of Fish and Wildlife and Washington Department of Fisheries (1976) for 1971-75.
[2]Green sturgeon entered the catch in 1913.
[3]Landings prior to 1925 are known only for the indicated years.

Table 2.—Average commercial sturgeon landings, in pounds, in Oregon and Washington coastal districts and in Puget Sound, 1939-73[1].

	Average annual landings (lb)		
Years	Oreg. coastal districts	Wash. coastal districts	Puget Sound[2]
1939-40	1,150	12,900	—
1941-45	2,380	40,600	5,033
1946-50	1,480	25,440	13,280
1951-55	860	44,100	8,080
1956-60	1,020	102,860	8,100
1961-65	5,220	132,520	25,740
1966-70	4,280	178,940	23,040
1971-73	10,667	155,833	9,133

[1]Sources: U.S. Fish and Wildlife Service (1942-69), and National Marine Fisheries Service (1970-76).
[2]Although these sturgeon are landed in Puget Sound ports, a great majority of them are captured in coastal waters.

PRODUCTS

In the early days of the fishery there were four products taken from sturgeon: the flesh, roe, spinal marrow, and swim bladders. The flesh was sold fresh and frozen; the spinal marrow was prepared and dried by the Chinese for use in making soups, and the bladders were used in manufacturing isinglass (Craig and Hacker, 1940). In recent years there has been a high demand for fresh, smoked, and canned sturgeon as well as the eggs which are used to make caviar.

DESCRIPTION OF THE FISHERY

Areas and Seasons

Sturgeon are taken commercially in coastal waters and in many coastal rivers of Oregon, Washington, and British Columbia as well as in Puget Sound. White sturgeon are taken mainly in the freshwater areas of the Columbia and Fraser Rivers; however, some are landed in Grays Harbor, Willapa Bay (Wash.), and in several other rivers. Green sturgeon are mainly taken incidentally to the other fisheries in coastal waters, the brackish water of rivers, and occasionally in Puget Sound. Sturgeon are caught during all commercial fishing seasons, with the largest catches being made between May and October.

Season closures for other species and size limits are the regulations that have provided protection for the sturgeon population in the northeastern Pacific. In the Columbia River, a minimum size limit of 4 feet (1.22 m) in the commercial fishery provides protection for the young sturgeon until they approach spawning size. The maximum limit of 6 feet (1.83 m) provides protection to the majority of the large female brood stock (footnote 1).

Gear

In the Columbia and Fraser Rivers, most commercially caught sturgeon are now taken in gill nets during salmon and steelhead trout (*Salmo gairdneri*) fishing, but a few are taken with handlines. In Puget Sound most of the catch is taken incidentally in otter trawls. However, small numbers are captured in gill nets and, occasionally, in purse seines. In the Washington coastal district most of the sturgeon are taken incidentally in gill nets, with small numbers taken in otter trawls. However, in recent years catches of about 10,000 to 29,000 pounds (4,535 to 13,152 kg) have been taken using set lines, primarily in the Grays Harbor area. In Oregon coastal areas, sturgeon are taken incidentally in otter trawls offshore and in gill nets in the rivers.

CURRENT TREND AND FUTURE STATUS

Construction of dams on the mainstream Columbia and Snake Rivers has considerably reduced available habitat, particularly in the Snake River. Dams restrict the migration of sturgeon and isolate them in the pools between dams. However, available habitat in the lower Columbia River below Bonneville has not changed greatly in recent years (footnote 1). Because sturgeon are slow growing and seldom spawn before the age of 15 years, overfishing has greatly depleted stocks in the past. Current regulations now in effect should protect sturgeon from overfishing in the future.

Sturgeon catches have been relatively stable during recent years on the Fraser River and have increased on the Columbia River. The incidental catches have generally been increasing in the Oregon and Washington coastal areas (Tables 1 and 2). These catches indicate that the commercial regulations, including size limits and the closed seasons for other species, have been successful in halting the decline in the sturgeon population and that the sturgeon populations are now relatively stable. As the fishery has become mostly incidental and the older fish are, therefore, largely unexploited, it seems likely that there is now an accumulation of older fish to maintain the populations and possibly support a modest increase in the landings.

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MFR Paper 1316. From Marine Fisheries Review, *Vol. 40, No. 7, July 1978. Copies of this paper, in limited numbers, are available from D822, User Services Branch, Environmental Science Information Center, NOAA, Rockville, MD 20852. Copies of* Marine Fisheries Review *are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 for $1.10 each.*

MFR PAPER 1317

The Atlantic Halibut and Its Utilization

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INTRODUCTION

In the early days the English thought highly of halibut, serving it on holy days. Since butte was the middle English word for flatfish or flounder, "holy butte" eventually became halibut.

Prior to a period near the middle 1800's the cod was the main species sought by fishermen from the northwest Atlantic region. This was because preservation of fresh fish aboard boats was not yet practiced, and the cod could be preserved by salting with subsequent drying. (Those boats fishing for cod relatively close to shore made many day trips, the fish being held in the eviscerated state.) The fish were beheaded, split, and salted after landing in port. On boats which made fishing trips of several days, weeks, or months, the eviscerated fish were beheaded, split, salted, and held in kench (piles of salted fish) aboard the boat. In those days the Atlantic halibut, *Hippoglossus hippoglossus,* was considered to be a trash fish and a pest since it oftentimes ate the cod which had been caught by the hooks attached to fishing lines.

With the advent of ice for preserving fish aboard boats, fishermen began to fish for other species that were found to have good eating quality, including the halibut, since fish could then be brought to shore and sold for consumption in the fresh state. This was especially the case when it was learned that ice distributed among fish was a more efficient method of preservation than that of placing fish in one part of a hold pen and ice in another part of the same pen. Also, the fact that fish could be preserved for some time by adequate icing provided for the sale of fresh fish inland at some distance from the shore. Since the halibut, prepared for consumption from the fresh state, is one of the most delectable of species, it soon became popular and was subsequently sought in quantity in the waters off the northeast areas of the United States and off Canada.

PHYSICAL CHARACTERISTICS

The halibut (Fig. 1), largest of the flatfishes, is a kind of flounder. Like flounders, the halibut maintains a lateral position so that one of its sides is up and the other side is down. It has a large mouth which extends back to the eyes, with sharp, curved teeth. In proportion, it is about one-third as wide as it is long but, compared with other flounders, it is relatively thick. The tail of the halibut is wide and slightly curved (concave). There are two small similar ventral fins located just below the gill covers. The dorsal fin starts above the eye and extends to the caudal peduncle (narrow part near the tail). It has 98-105 rays and is broadened near the midpoint. The anal fin is similar to the dorsal fin but somewhat shorter, starting behind the pectoral fin and running to the caudal peduncle. It has 73-79 rays and is preceded by a sharp, spine-like projection of bone which, in young fish, projects exteriorly but in the old fish is hidden by the skin. The pectoral fins are not alike, with the one on the upper side being obliquely pointed, and the pectoral fin on the lower side being rounded.

Halibut which weighed up to 600-700 pounds (272-318 kg) have been caught off the U.S. east coast but such large fish are now rare. Of those caught now, the large females average 100-150 pounds (45-68 kg) in weight and the large males 50-200 pounds (23-91 kg). At the same age the female is larger than the male. A 24-inch (61-cm) long halibut (head and tail included) weighs about 5.5 pounds (2.5 kg), while a 74-inch (188-cm) halibut weighs about 215 pounds (98 kg). Commercial sizes of halibut are "chicken," weighing 5-10 pounds (2.25-4.5 kg), "medium," weighing 10-60 pounds (4.5-27 kg), "large," weighing 60-80 pounds (27-36 kg), and "whales," weighing 80 pounds (36 kg) and over.

RANGE

In the western Atlantic halibut are found from the Gulf of St. Lawrence and the Grand Banks off Newfoundland to Nantucket Shoals. They are rarely found as far south as in the waters off New York.

BREEDING HABITS

The east coast halibut spawn from April through September. The eggs are comparatively large, 3.1 to 3.8 mm in diameter, and large females may produce as many as 2,000,000 eggs. However, the average mature females produce a small number of eggs. Since this is the case, it has been found that in order to conserve the stock, halibut must be protected from fishing during certain parts of the spawning season, and the quantity of fish taken from the various areas must be limited to a yearly quota. This kind of action has been taken on the west coast where halibut is still fished commercially. The Atlantic stock was badly depleted before effective management measures could be

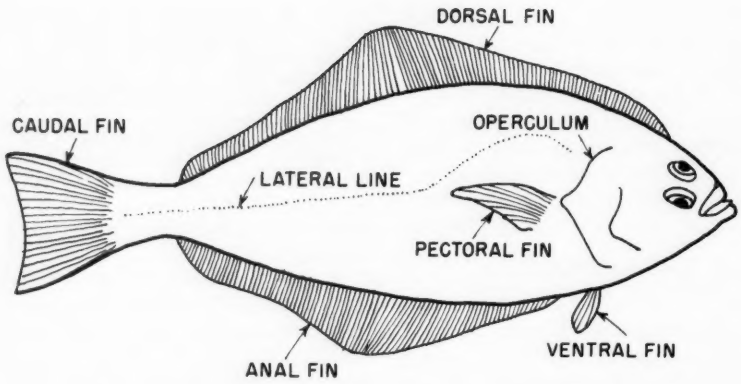


Figure 1.—The Atlantic halibut, *Hippoglossus hippoglossus* (Linnaeus).

applied, and because of the small size of the Atlantic halibut stock. Halibut is no longer a directed fishery in the Atlantic.

It is believed that the halibut spawn on the slopes of all offshore banks as well as on the continental slopes. The eggs are not buoyant but sink to the bottom where they are fertilized by the males. The period required for hatching of the fertilized egg is not known. The larvae are pelagic and stay close to the surface until they reach a size of 4-5 inches (10-13 cm) when they are about 1 year old. Small larvae, which are not pigmented, swim upright and have an eye on either side of the head. At a size of about 0.8 inch (2 cm) the left eye starts to migrate towards the right side of the head. At a size of 4 inches (10 cm) the left eye completes its migration to the right side of the head. The fish (about 1 year of age at this time) descend to the bottom area of the habitat. The right side of the fish, now the upper side, becomes pigmented, and, as it will as an adult, the young halibut lies on its left side on the ocean bottom. The color of the mature halibut is chocolate to olive or slaty brown on the upper (eyed) side. The lower side is white or white blotched with gray. The mature fish has small scales on the head and body, and it is covered with a slimy mucus. Halibut reach maturity at an age of 9-10 years.

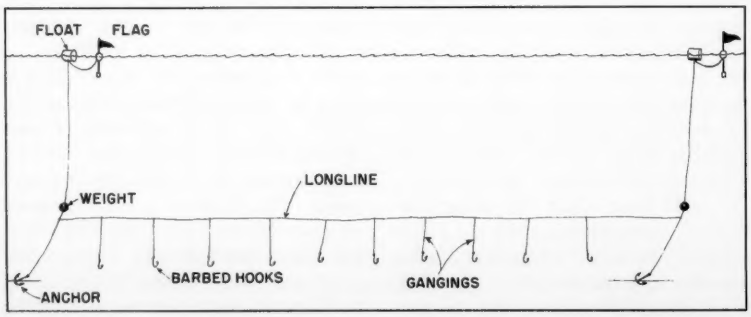
FEEDING HABITS

The food of the halibut consists mostly of other fish. Cod, cusk, haddock, ocean perch, sculpins, silver hake, herring, capelin, skates, flounder, mackerel, and others have been found in the stomachs of the east coast halibut. Clams, mussels, crabs, and lobsters are also eaten to some extent.

HARVESTING

Off the U.S. east coast we no longer have a directed halibut fishery. That is, vessels do not attempt to fish for halibut exclusively, and all of the halibut which is caught is only incidental to that of other species for which the fishing effort is directed. When vessels fished for halibut as the principal species, longlines were used. A longline (Fig. 2), which is still used for catching other species, consists of a comparatively large and long central line to which short smaller lines (gangings or snoods) are attached every few feet[1]. A large barbed hook is spliced to the end of each ganging. The hooks are baited (herring was used for halibut) and the line is let down with an anchor also attached to the line and to another with flag and float which remain on the surface. The baited line is allowed to rest on the bottom for some distance (in some instances long lines extend for several miles[2]). At the far end of the line another anchor, flag, and float are attached as at the beginning. The long line is allowed to remain on the bottom for some time after which the first anchor is pulled up and removed and the line is brought aboard the boat with the assistance of a revolving lock or gurdy. As the line is brought to the boat the fish are removed and, beyond the gurdy, the line is coiled into a tub and rebaited for another set. Where halibut fishing was carried out from dories, the lines were often underrun. That is, the anchor was pulled up and the line was placed over the bow of the dory. As the line was pulled in, the fish were removed, the hooks rebaited, and the anchor with line, float, etc. thrown back into the water to return to near the same area on the bottom where it was formerly resting. Halibut are still caught on longlines that are set for other species.

Figure 2.—The longline.



[1] 1 foot = 30.5 cm.
[2] 1 mile = 1.6 km.

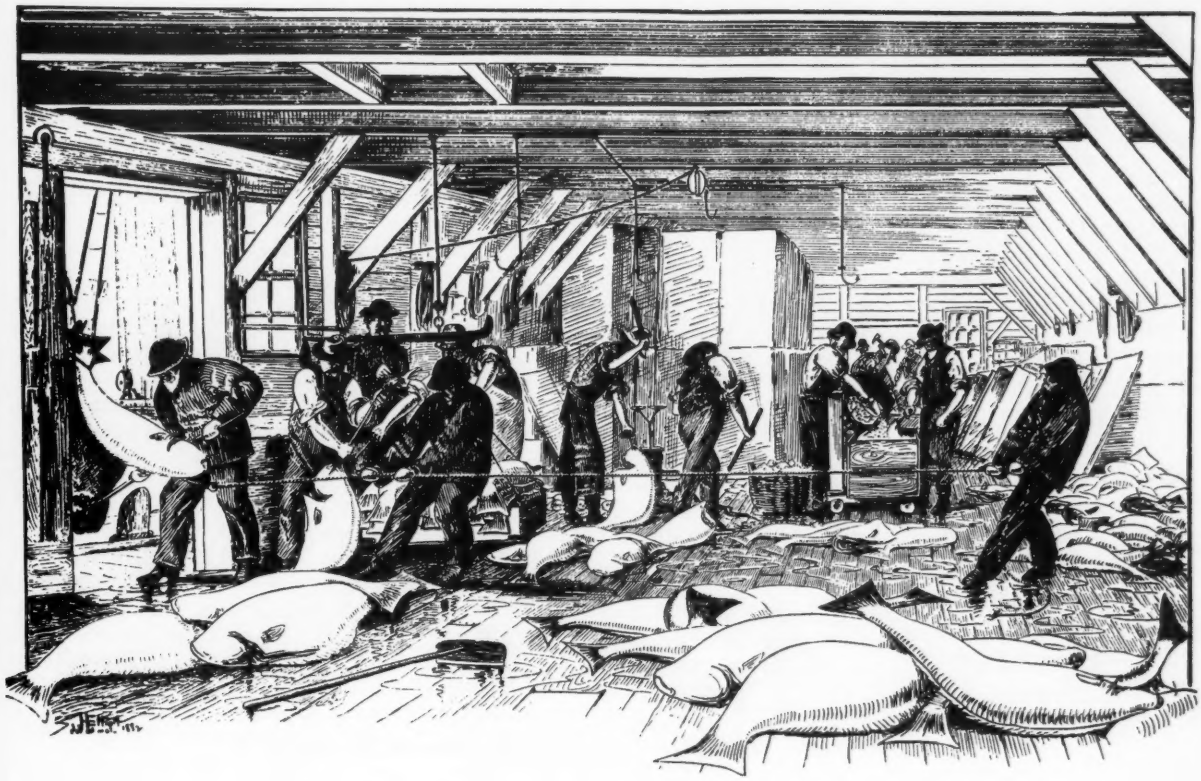


Figure 4.—Weighing, unheading, and packing fresh Atlantic halibut in ice for shipment by rail at Gloucester, Mass. Drawing by H. W. Elliott, 1882.

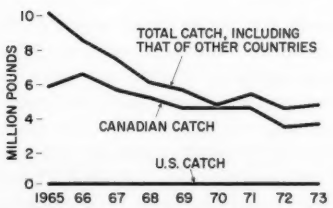


Figure 3.—Halibut catch from the northwestern Atlantic Ocean (1965-73).

It is reported that during the middle 1880's some 10,000,000 pounds (4,540,000 kg) of halibut were harvested from the northwest Atlantic Ocean. The port of Gloucester had about 40 vessels engaged in fishing exclusively for halibut, which was handled entirely as fresh fish. The vessels were among the best of the Gloucester fleet, averaging 75-80 tons (68-72.5 metric tons) and capable of relatively high speed for the time. The size of the crew was about 12. Halibut were gradually depleted from this area by overfishing and by taking fish during the spawning season. Eventually this species, which at one time was plentiful inshore, could only be caught in deep-water banks and it even became comparatively scarce in these areas. From the 1965-73 catch rates (Fig. 3) it can be seen that most of the catch was made by Canadian fishermen—about 4,000,000 pounds (about 1,800,000 kg) over the past few years. The U.S. catch is obviously relatively low at less than 250,000 pounds (about 100,000 kg) annually, and it has been rather constant throughout that period. As many as 14 countries fish for halibut; therefore, it is clear that the combined catch by countries other than Canada and the United States dropped remarkably from 1965 to 1970 when, it appears, only Canada and the United States landed any sizeable quantities. It can be seen from the graph that the total halibut catch decreased throughout the 1965-73 period, except for slight upward fluctuations in 1971 and 1973, and that the catch rate at the end of the period was reduced to approximately half that of 1965. The U.S. east coast landings in earlier times were as follows: In 1886, over 9,000,000 pounds (4,100,000 kg), in 1928, 4,257,000 pounds (1,933,000 kg), and in 1929 the same area provided less than 2,000,000

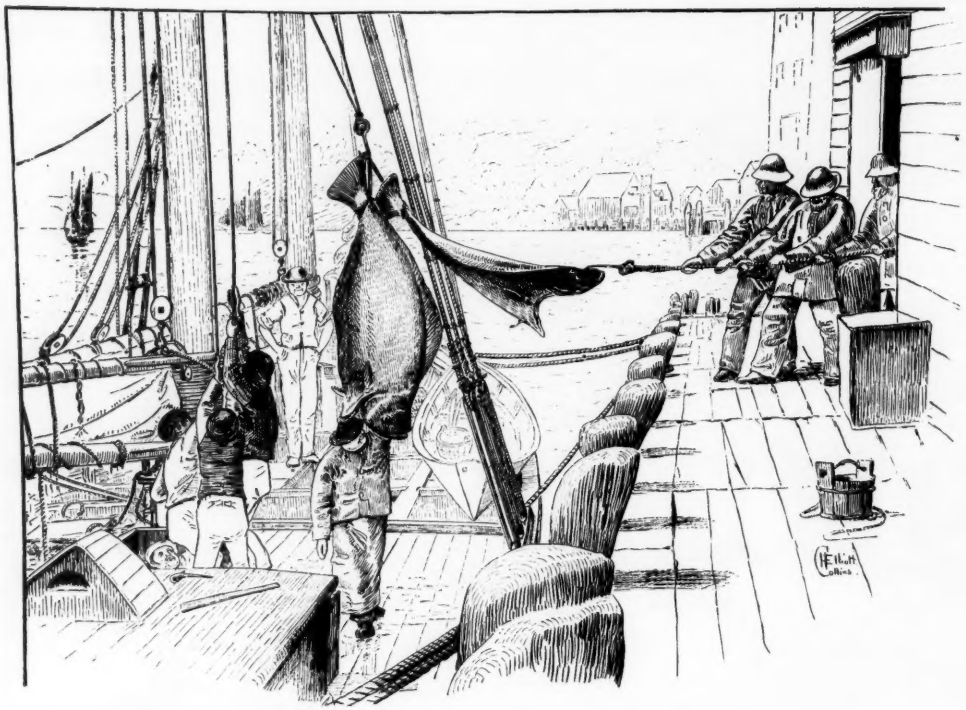


Figure 5.—Hoisting Atlantic halibut from the hold of a schooner at Gloucester, Mass. Drawing by H. W. Elliott and Capt. J. W. Collins.

pounds (900,000 kg). Since then, the catch has dwindled to about 250,000 pounds (113,500 kg).

HANDLING ABOARD BOATS

On the east coast all of the halibut caught is handled in the fresh state. When brought aboard fishing boats the throat of the halibut is cut, the belly is split, and the gills and entrails are removed by hand. The surface and belly cavity of the fish are then washed with seawater. The belly cavity (sometimes called the poke) may be filled with ice and the fish are placed in hold pens in layers that are alternated with layers of ice. Boats may remain at sea for as long as 7-10 days before returning to port, but the halibut keeps well under suitable icing and these fish are generally landed in port in good condition. At times there have been some cases of surface yellowing of the white side of the fish. This is due to the growth of a fresh water bacteria, *Pseudomonas flourescens,* and on the west coast this problem was solved by chlorinating the water used to make the ice which is used aboard the fishing boats.

HALIBUT UTILIZATION

Halibut are used mainly as food, although they are also used in the manufacture of other products of commerce. When landed in port, the fish are removed from the hold of the boat in a heavily roped wide mesh net which is hoisted to the dock. The fish are then beheaded, washed, and placed in boxes in layers that are alternated with layers of ice. In this condition they are shipped to the retailer or to some commission agent who will reship to the retailer.

On the U.S. east coast, halibut are so scarce that the relatively small landings are only from the incidental catch. All of this catch is handled in the fresh state with a portion of it going to members of the fishing crew, their families, and friends, and the remainder going to restaurants and to processors who supply the restaurants. Halibut are generally consumed as steaks, mainly because of their relatively large size. The steaks are made by cutting the body of the fish into transverse slices of about 0.75-inch (about 2-cm) thickness. When halibut meat is at its highest quality, it is among the best tasting of meats, and it is worth the high price that it commands—a price which is as high as that of high-priced beefsteak. In fact it has a somewhat meaty, though unique taste, and it is very tender without being mushy. Unfortunately, fresh halibut (i.e., halibut that has never been frozen) is only rarely available, and most of the halibut consumed has been caught off the west coast of the United States or in

other remote areas and arrives on the U.S. east coast in the frozen state. The fat in halibut, as in some other fish, is relatively high in the polyunsaturated fraction, and it is therefore readily oxidized, giving rise to rancid off-flavors and off-odors. Without proper handling and care, frozen halibut steaks can become rancid to some degree. In addition, the meat may become tough, and in some cases it may even become dehydrated which accelerates rancidity and further depreciates the quality of the texture. Thus, while halibut is an excellent food fish, an experience with improperly handled halibut may cause some consumers to believe otherwise.

In medium-sized or large halibut, portions of flesh from either side of the head weighing 0.5 pound or more, and accurately called halibut cheeks, are considered by many to be the most delectable parts of the fish. These are cut out by inserting a pointed knife below the eye and circling the cheek cavity while leaving a narrow strip of intact skin. The flesh is then cut through to the intact skin and the flesh is pulled away from the skin with which it is covered. Generally, halibut cheeks are sold as the fresh product although small quantities may be frozen.

The Atlantic halibut, which with suitable fishing regulations might have continued to provide a significant amount of animal protein to the consuming public, has become of little importance as a food for humans due to extreme fishing pressures over an extended period of time.

HALIBUT BY-PRODUCTS

Halibut heads, with or without the cheeks, are utilized for the manufacture of fish meal, a cooked dehydrated product which is used to supplement feed for cattle, hogs, and chickens.

Halibut livers are rich in vitamin A and (once) brought a good price since the oil could be extracted and used for medicinal purposes. When synthetic vitamin A was developed, halibut livers became less important, although there is still some utilization of halibut livers. The livers are taken when the fish are eviscerated aboard the fishing boat and held under refrigeration. In port, the livers are heated and pressed to obtain an oil-water-protein mixture which is allowed to settle or which is centrifuged to obtain the clarified oil. The oil content is in the range of 5-19 percent.

Halibut skins have been used to produce fine leathers by the chrome tanning process which produces softer more pliable leathers than can be produced by the vegetable tanning process. Halibut leathers are easily dyed in a variety of colors and have an attractive surface design resulting from the removal of the scales from their follicles.

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Marine Currents May Have Caused 1976 New Jersey Fish Kill

A massive 1976 fish kill off New Jersey may have been caused in part by an unusual combination of ocean currents, according to scientists with the National Oceanic and Atmospheric Administration (NOAA).

Gregory Han, Donald Hansen, and Jerry Galt of the Commerce Department agency's Environmental Research Laboratories have studied the ocean currents off New Jersey for the summer of 1976, when severe oxygen depletion turned the waters deadly. They reported, at a recent meeting of the American Geophysical Union, that an uncommon current pattern prevailed which could have transported phytoplankton from a wide region and concentrated them in one area, where they contributed to the consumption of oxygen in the bottom waters.

Han emphasized that the study demonstrated only one possible cause of the mortalities. "We've shown a mechanism for concentration of plankton and other organic material, but we can't tell how much oxygen these organisms were actually burning," he said.

It originally was thought that the anoxia might be caused solely by phytoplankton naturally occurring in the area, combined with normal summer stratification of the water. When the plankton drifting on the surface die, their remains sink to the bottom and decompose, a process that consumes oxygen. Stratification, in which waters form stable layers, tends to cut off the bottom waters from infusions of oxygen from the atmosphere.

There was more to it than that in this instance, according to Han. He and the other scientists used a computer model developed by Galt to simulate the currents off New Jersey during the summer of 1976. The model uses data on currents, water density, and temperature to provide a picture of water movements.

Much of the data used in the model came from an intense environmental study of the New York Bight—a section of the Atlantic Ocean between Long Island and New Jersey—by NOAA's Marine Ecosystems Analysis (MESA) program. This information came from current meters moored in the area, and other types of measurements made from ships during routine research voyages.

"During the summer," Han said, "the currents east of New Jersey normally flow to the southwest. But in 1976, winds from the south turned the flow around near the shore, pushing it northward, back toward the mouth of the Hudson River. There was a convergence of currents, and this could have brought in, and concentrated, organisms and organic matter from all over the Bight." This event, in turn, was coupled with an upwelling of water near the shore, he said. "So you had an onshore flow along the bottom, and an offshore flow at the surface." The waters flowed north, rose, and flowed back to the southwest.

The converging currents were capable of concentrating large numbers of a type of phytoplankton called *Ceratium tripos* in a relatively small area, where they could have become trapped by their own natures, according to Han. Different species of phytoplankton prefer to live at different depths, and *Ceratium* is found at the level where the currents converged.

The phyloplankton added substantially to the consumption of the area's supply of oxygen, both through respiration, and decomposition, the NOAA scientists believe. Other types of organic matter brought in by the currents would also have decomposed, using still more oxygen.

NOAA Scientists Trace Gulf Stream Meanders

Satellites operated by the National Oceanic and Atmospheric Administration are helping that agency's scientists explore and map the intricate, meandering collection of ocean currents stemming from the Gulf Stream. This complex current system, the NOAA scientists have reported, can now be mapped in detail from the tip of Florida to Labrador's Grand Banks in two days, a task formerly requiring weeks of ship time to accomplish.

This is one of the results of a study reported at the recent meeting of the American Geophysical Union in Miami, Fla., by George A. Maul, P. Webb DeWitt, Alan Yanaway, and Stephen R. Baig of the Commerce Department agency. According to Maul, an oceanographer with NOAA's Atlantic Oceanographic and Meteorological Laboratories in Miami, the constantly shifting meanders along the west wall of the Gulf Stream in particular are of importance not only to mariners, but to those concerned with the carry-off of pollutants in coastal waters and other phenomena.

Shipboard time-series studies using current meters and other equipment in the Gulf Stream system indicate that meanders have longer periods in some regions than in others. While an annual period seems to dominate the system in the eastern Gulf of Mexico, meander periods in the region between Cape Hatteras, N.C., and the Grand Banks southeast of Labrador are about 1.5 months. Other shipboard surveys have revealed that the fluctuations in the Gulf Stream current boundary may last 4-10 days in the Straits of Florida near

Miami, and 4-7 days at Onslow Bay, N.C.

"Little is known about meander periods briefer than a fortnight in the Gulf Look Current or in the Gulf Stream northeast of Cape Hatteras," the NOAA scientists reported, "or about longer (monthly or annual) periods in the Straits of Florida or off Onslow Bay."

Furthermore, it is not practical to simultaneously study the meanders along the entire 1,500-nautical-mile (2,750-kilometer) Gulf Stream system between Cuba and Labrador by conventional shipboard techniques, Maul and his colleagues said. As a result, the NOAA scientists concluded that satellite observations of the sea surface temperature pattern associated with the entire current system is presently the only practical method for synoptically tracking the meanders.

Before the launch of NOAA's first geostationary operational environmental satellite in 1974, many satellite investigations were limited to case studies using a few good cloud-free examples. The GOES satellite, however, has an operational 30-minute observation schedule which means the images can be put together in a continuous sequence so that, on the average, the entire current can be located every 2-3 days.

As a result, Maul and Baig, who is with NOAA's National Environmental Satellite Service, located the entire Gulf Stream from the Yucatan Strait between Mexico and Cuba and the Grand Banks near Labrador, Canada, using satellite image sequence techniques. A subsequent study of the Gulf Stream by another scientist used GOES data to investigate meanders off Onslow Bay, N.C., and found frequencies similar to shipboard observations made in 1961.

Foreign Fish Boats Off U.S. Coasts Increase in March

The number of foreign fishing vessels sighted in the United States 200-mile conservation zone increased from 206 in February to 248 in March, according to preliminary figures released by the National Oceanic and Atmospheric Administration. The ships, sighted by the Commerce Department agency's National Marine Fisheries Service and Coast Guard personnel, were from six foreign nations.

The largest number, 143, was from Japan which had 123 vessels fishing for groundfish and pollock off Alaska, 15 fishing for tuna in the Gulf of Mexico, and five fishing for squid off New England and the Mid-Atlantic coasts. The Soviet Union had 56 vessels fishing for groundfish in Alaskan waters, and 19 vessles fishing for squid and hake off New England and the Mid-Atlantic States.

The summary of foreign fishing vessels operating off U.S. coasts during March 1978 and March 1977 is given in the accompanying table.

Foreign vessels sighted off the coasts in 1976 were as follows: January—420, February—510, March—435, April—560, May—924, June—970, July—842, August—543, September—514, October—452, November—258, December—240. In 1977: January—319, February—314, March—180, April—235, May—374, June—767, July—786, August—492, September—437, October—378, November—256, and December—188. In 1978: January—158, February—206, March—248.

Foreign fishing vessels sighted off U.S. coasts in March 1978 and 1977.

Area	Nation	No. of Vessels March 1978	No. of Vessels March 1977
New England and Mid-Atlantic	Canada	0	1
	Japan	5	14
	Mexico	2	0
	Soviet Union	19	24
	Spain	21	21
		47	60
Gulf of Mexico	Japan	15	0
Alaska	Japan	123	73
	S. Korea	6	1
	Soviet Union	56	46
	Taiwan	1	0
		186	120
Total		248	180

Fishing Vessel Accidents Eyed

The causes of fishing vessel sinkings and accidents will be studied by University of Washington scientists under a $1,794,000 National Oceanic and Atmospheric Administration (NOAA) Sea Grant announced by Secretary of Commerce Juanita M. Kreps. The study, being done in cooperation with NOAA's National Marine Fisheries Service, could result in saving lives and millions of dollars worth of fishing craft, the scientists believe.

The project is one of 51 to be pursued by Sea Grant scientists at Washington under the grant, which will be augmented by non-Federal matching funds of $1,025,000, according to Ned A. Ostenso, Director of NOAA's National Sea Grant Program. The researchers plan to compile an extensive record of accidents involving commercial fishing vessels so that a permanent Fishing Vessel Safety Analysis Center, similar to the military's Aviation Safety Centers, can be established.

Cooperating in the collection of data will be the U.S. Coast Guard, underwriters, vessel owner associations, legal representatives, and individual fishermen. Benefits of such a data base, say the researchers, will be availability of information from a single source, more accurate statistics, more effective safety programs, and wide dissemination of the underlying causes of accidents with anticipated reductions in losses of lives and vessels.

In addition to the study of fishing vessel casualties, other new projects being initiated this year include an investigation into the distribution, abundance, growth, and residence time of juvenile salmon in the Skagit salt marsh; a program, along with industry, on genetic improvement on salmon being raised in pens; a study into the economic impact of marine recreational boating in Washington, being underta-

ken in cooperation with the Northwest Marine Trade Association; and, a program to develop teaching materials for two sequential courses outlining how to use environmental information in making decisions in coastal management.

Two other new educational projects will be initiated at the University's Institute of Marine Studies. One will be to develop a syllabus of readings for a course in ocean law enforcement, and the other to develop a seminar course on the technical, legal, economic, and environmental aspects of managing marine resources.

Under this year's grant, marine advisory services will continue at about the same level of effort as last year, although much more emphasis will be placed on the establishment of a stronger field program in the Columbia River region.

Bowhead Whaling Rules Published

Final regulations controlling the subsistence hunt of bowhead whales by Alaskan Eskimos during 1978 have been published by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service. According to the Commerce Department agency, these regulations implement the limited aboriginal subsistance quota adopted by the International Whaling Commission (IWC). Effective 20 March 1978, Alaskan Eskimos were required to adhere to the bowhead whale quota of either 12 landed or 18 struck.

The regulations allocate the IWC quota among the affected villages (Kaktovik, Nuigsut, Barrow, Wainwright, Point Hope, Kivalina, Gambell, Savoonga, and Wales) and provide that, once a village has achieved its quota, it must cease whaling. If a village does not reach its quota, the remaining portion may be reassigned to another village. The regulations provide for licensing of whalers, prohibit whaling in a wasteful manner, and establish requirements for marking weapons.

Residents of nine villages annually hunt the whales during their spring and fall migrations through openings in the sea pack ice near their villages. Whale hunting has been an important part of the culture and subsistence lifestyle of Alaska Eskimos for centuries. The spring hunt, when most whales are taken, begins about 1 April, depending on ice conditions, and lasts 6-8 weeks.

In addition to the Federal regulations, the Alaska Eskimo Whaling Commission (AEWC) has prescribed regulations for its member whaling captains to assure that the equipment and whaling techniques used will complement the Federal regulations and will promote the use of the best means possible to reduce the number of whales that are struck and not landed.

NOAA will implement a $700,000 multi-year research program to determine the status of the bowhead whale stock. The Eskimos have agreed to assist in the program by allowing the research personnel access to the whales that are landed and permit them to take specimens. Eskimo whalers will continue to count whales after the hunt has ended and report the results to the research party. NOAA will assist in establishing additional research camps on the ice in response to a suggestion by the AEWC.

NOAA has made arrangements with a commercial company to investigate possible modifications and improvements in the weapons used by the Eskimos to reduce the number of whales that are struck and lost due to improperly functioning weapons. A representative of the company visited the villages in March to instruct the whalers on the proper procedures to load the munitions and to demonstrate the use of the weapons. If the weapons need additional modifications, NOAA will fund additional development work needed on the weapons.

NOAA will provide eight electronic "pingers" and two tracking devices to at least two of the Eskimo whaling captains so that the research team can test the effectiveness of the tracking devices to follow whales that have been struck in order to facilitate recovery.

The U.S. has arranged for an international observer from Denmark to observe the hunt and will provide accommodations for the observer.

Eskimos will be employed by the National Marine Fisheries Service to assist NMFS enforcement agents that will be used as monitoring teams in six of the Eskimo villages during the spring hunt. The Eskimo will be a Federal employee while a member of the team and will assist the NMFS agents in informing whalers of the strikes and landings of other whalers, recording information, performing inspections, and carrying out any necessary investigations.

After a village has reached its quota, the NMFS agents will leave and the locally hired employee will continue to monitor activities of the village. Information gathered by the local reporting officer will be made available to the AEWC which may use the information for enforcement of the AEWC regulations.

Scientists Observe Caribbean Currents

The surface waters of the Caribbean may retain pollutants longer than existing current charts suggest, according to a National Oceanic and Atmospheric Administration (NOAA) scientist. Reporting at an April meeting of the American Geophysical Union in Miami Beach, NOAA oceanographer Robert Molinari described results from a recent study which used satellite-tracked

buoys to trace the circulation of the region.

Molinari said that Caribbean surface currents were much more complicated than had been generally believed, so that water—and any pollutants it may receive—would tend to remain in the Caribbean for months before returning to the Atlantic through the Florida Straits. "This longer residence time has implications for environmental impact studies, since any pollutants discharged in the region would remain longer than previously assumed," he said.

The conventional view of currents in the area, explained Molinari, a researcher with the Commerce Department agency's Atlantic Oceanographic and Meteorological Laboratories in Miami, is based on "pilot charts," compiled from numerous ship observations spanning the last century. The charts show a simple pattern of water movement in the Caribbean—a flow from east to west, at about a knot or a knot and a half (slightly over a mile an hour), with little north-south variation. The new buoy results show quite a different picture.

For the study, Molinari and colleagues at Nova University and the University of Puerto Rico deployed a total of 19 mini-buoys at the eastern end of the Caribbean Sea. The buoys carry wind sensors and drogues—a type of underwater parachute that ties the buoy to the water and minimizes the effect of wind. In October 1975, scientists on the NOAA ship *Researcher* deployed eight of the buoys in the passages between islands of the Lesser Antilles. Three months later 11 more were set afloat, within several passages, and west of the undersea Aves Ridge. Their movements were tracked by satellite, averaged together, and plotted on charts. The results did show a general east-to-west flow, but hardly in a direct line.

The buoys made large excursions to the north and south, Molinari reported, carried by meanders (winding currents) and eddies (circular, whirlpool-like motions). In the Grenada Basin, between the Lesser Antilles and the Aves Ridge, eddies as large as 60 miles (100 km) across caught the buoys. Meanders carried them 150 miles (250 km) to the north and south. The course of these meanders described a wave pattern across the sea, watery oscillations with a wavelength of 240 miles (400 km), the same as the distance between the major ridges in the basin. Molinari plans further study to see if the two observations are related.

In the corner of one basin of the sea, the researchers found the waters rotating in the opposite direction from that shown on pilot charts. They also found that the flow in the eastern Cayman Sea, south of Cuba, is dominated by a large eddy. The researchers were surprised at how their results differed from the pilot charts, but, according to Molinari, "the charts are based on the movements of ships, a ship's motion is affected by the wind as well as currents, and the winds do blow pretty consistently from east to west."

The main implication of their findings, Molinari said, is that things stay in the Caribbean longer than thought, implying that pollutants might have a greater effect, because it would take longer for circulating waters to flush them out. Other implications are less obvious. The Caribbean, the NOAA scientist pointed out, is a part of the North Atlantic Gyre, the grand clockwise circulation that includes the Gulf Stream. What happens here affects what goes on in the entire North Atlantic, he said.

Study Boosts Foreign Sales for U.S. Fish

A $400,000 contract to study the structure and trade barriers of foreign markets for species of fish which, although abundant off U.S. coasts, are little used domestically, has been awarded to Earl R. Combs, Inc.[1], Seattle, Wash., by the National Oceanic and Atmospheric Administration (NOAA).

The Commerce Department agency's study also will determine the capability of the U.S. fishing industry to produce products for these markets, according to NOAA Administrator Richard A. Frank. "This study is part of NOAA's continuing effort to improve the economic health of the domestic fishing industry by encouraging development of new export markets for U.S. fishermen," Frank indicated. The project, lasting a year, will examine markets in 16 European and Far Eastern countries where many fish underutilized in the U.S. are considered delicacies. Squid, herring, eels, and various underused groundfish are in short supply overseas.

By examining market structure, price mechanisms, and trade barriers, the study will identify potential market areas and provide the U.S. fishing industry with information on marketing techniques, pricing mechanisms, and product type and demand in specific market areas. The project also will identify potential demand for fish and shellfish, including underutilized species, in domestic markets. Both domestic and foreign impediments to development of these fisheries will be reviewed. Such items as tariffs, gear regulations, border taxes, and quotas all may serve to inhibit the development of markets or the supplies needed.

The contract is funded by six Department of Commerce units: the National Marine Fisheries Service, the Economic Development Administration, and four Regional Commissions (Coastal Plains, Pacific Northwest, Upper Great Lakes, and New England).

Frank emphasized that the U.S. fishing industry had helped design the study and would participate in its development. Noting the study was a significant step in identifying specific markets for fish products available in the United States 200-mile zone, he said it will provide guidance to the fishing industry on when and how to develop this potential.

The contractor will visit various industry groups to gather information.

[1]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

throughout the project. In the fall, a National Conference on Fishery Development will be held to review the findings of the study. However, during the progress of the work, findings of immediate use and interest will be relayed to industry so that opportunities may be taken advantage of as they appear.

NOAA Monitors Marine Mining Tests in Pacific

Operational test-mining of the deep ocean floor was underway for the first time in history in the central Pacific Ocean in April, with scientists from the National Oceanic and Atmospheric Administration (NOAA) on-site to evaluate their impact on the marine environment.

A converted ocean oil-well drilling ship, the *Sedco 445,* owned by one of a group of U.S., Canadian, West German, and Japanese companies that make up Ocean Mining, Inc.[1], was pumping manganese nodules from the sea bed at a depth of more than 3 miles, testing a system by which the nodules are collected, separated from other ocean floor material, and lifted up to the vessel.

During the early stages of the test period, the NOAA Ship *Oceanographer,* working nearby the *Sedco 445,* observed the effect of these activities. Two separate events were also monitored: the plume of materials along the ocean floor generated as the collector draws in and separates the nodules and other materials, and a surface plume caused by shipside disposal of excess materials brought to the surface along with the nodules.

The precise environmental effect of both events is uncertain, requiring their monitoring, according to Robert E. Burns, NOAA's chief scientist on the project. The Commerce Department agency official was doing his monitoring with previously-placed ocean bottom instruments, while a colleague, mineralogist Leal Kimrey, was aboard the *Sedco 445,* sampling the surface discharge. These monitoring activities are essential to the planning of future Federal regulation of ocean-mining operations.

Later in April both ships sailed the 1,000 miles northwestward to Honolulu where the *Sedco 445* was to be refitted to return to the work area and test a different collection system. The *Oceanographer* was to monitor this activity, as well, which was expected to last until mid-May.

The mining tests and environmental studies, both of which started early in April, culminate extensive preliminary activites. Industry has been working for several years to develop techniques for collecting the nodules, while NOAA researchers have been engaged in baseline studies of the waters, life forms, and sea bed prior to the start of the mining tests. The nodules are roundish lumps of rock containing high concentrations of nickle, copper, manganese, and cobalt. When the current series of tests is completed, NOAA's deep ocean mining team will maintain a watch over the mining site, observing how it recovers, and how long the recovery will take.

[1]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

Seafood Taste Test Method Is Developed

As part of a program to further domestic use of traditionally underutilized fishery resources, the Fisheries Development Division of the National Marine Fisheries Service (NMFS) Southwest Region has designed a taste test methodology to evaluate new seafood preparation. Interval scales of seven are used to rate food items in terms of appearance, texture, flavor, and overall eating quality. Single-word adjectives describe the ends of each scale, and the remaining five intervals are left unlabeled. For analysis purposes, integer values are assigned to each scale interval after the taste testers have rated the food.

The developed methodology was used to test the taste acceptability of Pacific hake and walleye pollock dishes at two Los Angeles food conventions. A description of the test situation and results can be obtained from: Fisheries Development Division, National Marine Fisheries Service, NOAA, P.O. Box 3266, Terminal Island, CA 90731. Their telephone number is: (213) 548-2571.

Benton Named Associate Administrator of NOAA

George S. Benton, former President of the American Meteorological Society and former Vice President of Johns Hopkins University, has been nominated by President Carter as Associate Administrator of the National Oceanic and Atmospheric Administration (NOAA), it has been announced. The nomination requires confirmation by the Senate.

NOAA Administrator Richard A. Frank said Benton, one of the Nation's leading authorities in the atmospheric, oceanic, and hydrologic sciences, will significantly strengthen the Commerce Department agency's management team. President of the American Meteorological Society in 1969, Benton received his bachelor and doctorate degrees at the University of Chicago, and joined the faculty at Johns Hopkins in 1948. He was appointed Professor of Meteorology there in 1957, and Chairman of the Department of Mechanics in 1960.

For three years, from 1966 through 1969, he was Director of the Research Laboratories of the Environmental Science Services Administration, a predecessor of NOAA. In 1970 he returned to Johns Hopkins as Chairman of the Department of Earth and Planetary Sciences. He became Dean of the Division of Arts and Sciences in 1971, and Vice President of the Homewood Divisions in 1972. In addition to gaining an international reputation for his academic activities, Benton is professionally recognized for his research, which has been primarily concerned with the mechanics of rotating and stratified fluid systems, including the atmosphere and the oceans.

Soviet Union and Japan Agree on 1978 Quotas

The Soviet Union and Japan concluded negotiations on their 1978 catch quotas in each other's 200-mile fishery zones late last year in Moscow. Japan's total 1978 allocation in the Soviet zone was set at 850,000 metric tons (t); the Soviet Union's quota in the Japanese zone at 650,000 t. These final quotas, which were disappointingly low for the Japanese, reflected the Soviets' basic position throughout the talks, i.e., the so-called "equivalent principle," or the principle or reciprocity based on roughly equal allocations.

Before the negotiations began on 22 November, the Soviet Ministry of Fisheries said it would be willing to approve as much as 840,000 t for Japanese fishermen in the Soviet zone. The Ministry at that time also proposed a 670,000-t quota for Soviet fishermen in the Japanese zone. These 12-month figures were arrived at by simple extrapolation of the 1977 quotas, which were 700,000 t for Japan during March-December and 335,000 t for the Soviet Union during July-December.

The Soviet Union modified its position during the first week of negotiations, demanding that Japan increase the 1978 quotas for Soviet fishermen to enable them to catch as much as the Japanese in the Soviet zone. On 28 November, the Soviets proposed that Japanese fishermen be allowed to catch only 700,000 t (the same as the March-December 1977 quota) and threatened to reduce Japanese quotas even further if their demand was not met. This tough Soviet demand came in response to the Japanese proposal of a 378,000-t quota for Soviet fishermen, only 43,000 t more than their quota for the last 6 months of 1977.

The failure to agree on a quota formula continued throughout the negotiations. On 13 December, the Soviet Minister of Fisheries Aleksandr Ishkov presented to Japan the final Soviet quota proposal, the 850,000-t and 650,000-t figures which Japan ultimately accepted.

However, on the day the proposal was made, Japan rejected it because the 850,000-t quota represented only about half of the previous maximum catch by Japanese fishermen in Soviet waters, while the 650,000-t quota was roughly equal to the past maximum Soviet catch off Japan. Japan also expressed opposition to extrapolating its 700,000-t March-December quota for 1977 into a 12-month quota for 1978 by adding amounts for January and February only.

Because Japanese vessels were not allowed to fish in the Soviet zone during April and May while negotiations on an interim agreement were in progress, the Japanese felt that the 700,000 t quota should also be adjusted to reflect the ban on fishing during those 2 months.

Unless otherwise noted, material in this section is from the Foreign Fishery Information Releases (FFIR) compiled by Sunee C. Sonu, Foreign Reporting Branch, Fishery Development Division, Southwest Region, National Marine Fisheries Service, NOAA, Terminal Island, CA 90731, or the International Fishery Releases (IFR) or Language Services Daily (LSD) reports produced by the Office of International Fisheries, National Marine Fisheries Service, NOAA, Washington, DC 20235.

When it became evident, however, that the Soviet Union would never agree to the Japanese proposal for a 378,000-t Soviet quota in the Japanese zone and would not consider a revision of its own quota proposal based on the "equivalent principle," Japan informed the Soviet Union on 15 December that it would accept the Soviet figures. This decision was also influenced by the fact that Japanese fishermen would not be able to begin operations in the Soviet zone in early 1978, if the Soviet proposal were rejected.

Japanese Agriculture and Forestry Ministry officials stated on the night of 15 December that it was inevitable for Japan to agree to the Soviet proposal, although they were disappointed with the results. Japan's 850,000-t allocation represents a 45 percent decrease from its 1976 catch of 1,538,000 t, while the Soviet allocation of 650,000 t is only about 2 percent less than their 1976 catch.

The exchange of letters on the overall quotas was conducted on 16 December. A protocol on the 7-year extension of the two Soviet-Japanese interim agreements, which was negotiated in October, was also signed. That evening specific species quotas were worked out by the two countries.

JAPAN'S ALLOCATIONS

Over 40 percent, of 345,000 t, of Japan's total allocation in the Soviet zone is Alaska pollock (Table 1). The Soviet Union originally proposed a pollock quota of 260,000 t, but increased it to the present level during negotiations on 16 December. Despite the increase, the 345,000-t quota is still less than one-third of the 1,073,000 t caught in 1976.

For other principal species, the Japanese quota for ocean perch was increased to 22,000 t from 4,000 t in 1976 and for cod to 44,700 t from 38,000 t. The quota for squid was set at 146,400 t and for saury at 68,600 t.

The 4,100-t quota for crab (hair, brown king, and tanner) was reduced sharply from the 5,300 t permitted during June-December 1977 and the

Table 1.—Japan's 1978 quotas in seven fishing areas within the Soviet 200-mile zone (in metric tons).

Species	Areas[1] 1	2	3	4	5	6	7	Total quota 1978	Actual catch 1976	1978 quota as % of 1976 catch
Pollock	—	199,900	2,700	—	—	65,500	76,900	345,000	1,073,000	32
Squid	—	38,200	2,000	—	—	2,000	104,200	146,400	111,000	132
Sand lance	—	—	—	63,500	—	—	1,700	65,200	42,000	154
Flounders	—	21,900	1,900	—	—	1,000	5,500	30,300	68,000	45
Ocean perch	—	21,800	200	—	—	—	—	22,000	4,000	550
Cod	—	31,000	4,900	—	—	100	8,700	44,700	38,000	118
Wachna cod	—	13,900	—	—	—	1,500	100	15,500	13,000	119
Atka mackerel	—	2,400	500	1,000	—	300	6,800	11,000	43,000	26
Shrimp	—	—	—	—	—	—	500	500	7,000	7
Saury	—	66,600	1,000	—	—	1,000	—	68,600	39,000	176
Octopus	—	1,600	800	200	—	—	900	3,500	n.a.	—
Other fish	—	67,700	1,500	2,400	—	1,500	7,700	80,800	69,000	117
Red tanner crab	—	—	—	—	—	—	2,300	2,300	5,000	46
Crabs	—	—	—	800	800	2,500	—	4,100	16,000	26
Snail	[2]1,800	—	—	—	—	[3]700	—	2,500	4,000	62
Tuna and skipjack	—	6,400	—	—	—	—	—	6,400	6,000	107
Sharks[4]	—	1,200	—	—	—	—	—	1,200	n.a.	—
Total	1,800	472,600	15,500	67,900	800	76,100	215,300	850,000	1,538,000	55

[1]See Table 2 and Figure 1.
[2]Shucked
[3]With shell
[4]Excluding dogfish shark
Source: Regional Fisheries Attache, U.S. Embassy, Tokyo.

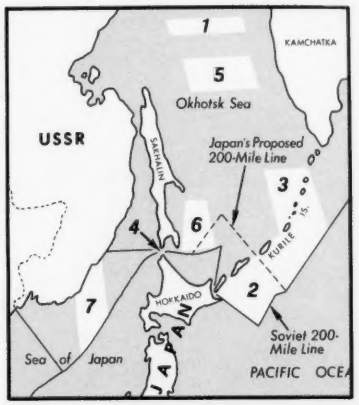

Figure 1.—Areas open to Japanese fishing in 1978, per Russian-Japanese accord: 1) Northern Okhotsk Sea; 2) Kuriles, Pacific side; 3) Kuriles, Okhotsk side; 4) Nijo-Iwa, northern Hokkaido; 5) Okhotsk Sea; 6) East Sakhalin; 7) Sea of Japan, Primorskaya.

16,000 t caught in 1976. The species breakdown is: hair crab, 800 t; brown king crab, 800 t; and tanner crab, 2,500 t. The 1978 quota for red tanner crab is 2,300 t, a decrease of 46 percent from the 5,000 t caught in 1976.

Japan received no quota for herring in 1978. Following the conclusion of the first interim agreement in May 1977, the Soviet Union banned Japanese fishing for herring in its waters. This ban has been extended through December 1978. Negotiations on high-seas salmon fishing were to be conducted in early 1978.

Japan was permitted to deploy a total of 6,546 fishing vessels in specific areas in the Soviet zone in 1978 (Table 2, Fig. 1). According to press reports, the number of coastal fishing vessels was reduced by 27. An additional 20 vessels

Canadian Fish Hatchery Utilizes Solar Energy

Use of solar energy to heat the water of a Federal Government fish hatchery is being tried by the Canadian Department of Fisheries and the Environment, that agency reports. Scheduled for full operation by the end of May, the solar project was installed at the Fisheries and Marine Service's Experimental Fish Hatchery in the municipality of Rockwood in Manitoba's Interlake region.

Representing the first practical application of solar energy in a Federal Government facility, the installation is expected to supply 70 percent of the annual heating needs of the hatchery, which raises fish for research purposes. Normally, groundwater at a constant temperature is pumped into the hatchery and then heated electrically to accelerate growth rates of the fish.

"We feel there is a potential for widespread application of this heating method by commercial and government hatcheries throughout North America," said Canada's Fisheries Minister Roméo LeBlanc. "Similar concepts may be tried at other Federal Government fish hatcheries in the near future." An attractive feature of the project is that the life cycle costs of the proposed system are expected to be lower than those of a conventional heating system.

A call for tenders for the required 1,250 square feet of flat plate solar collector for the hatchery project went out to leading Canadian manufacturers. This was in keeping with the Federal Government's objectives to develop a strong solar energy manufacturing industry in Canada. Actual installation was carried out by the hatchery staff. Preliminary research and design for the project was carried out by a departmental energy conservation consultant. A $40,000 grant from the Renewable Energy Policy Branch of the Department of Energy, Mines, and Resources enabled the project to get off the drawing board.

were reportedly cut out by the agreement, eliminating a potential crab catch of 500 t off the eastern Kurile Islands. Newly permitted were 301 vessels for the tuna fishery and 26 vessels for the shark fishery.

RUSSIA'S ALLOCATIONS

Almost 50 percent of the Soviet Union's total allocation in the Japanese zone is sardine and mackerel. The 318,000-t quota is an 11 percent increase over the actual 1976 catch of these species (Table 3). Soviet quotas for itohikidara and sand lance were set at the same levels as the 1976 catch, while the 80,000-t pollock quota is 54 percent less than the 174,000 t caught in 1976. Under the agreement, the Soviet Union may deploy up to 503 vessels in the Japanese zone in 1978.

REACTIONS TO ALLOCATIONS

Fishermen in northern Japan, who in recent years have supplied from the Soviet zone about 15 percent of Japan's total catch, appear to have accepted the Soviet zone as a fact of life. Their criticism of this latest Japanese-Soviet fishery agreement has focused on the Japanese Government's inability to obtain more than a 850,000-t overall quota. They are particularly dissatisfied with the pollock, crab, and shrimp quotas, which are expected to result in the idling of about 60 vessels, mainly from Hokkaido[1]. They are also unhappy over the Government's failure to gain increased access to fishing grounds in the Soviet zone, without which they fear that Japanese vessels may have difficulty catching enough fish to fill their quota allotments. Furthermore, there has been grumbling in industry circles that, by agreeing to a 650,000-t Soviet quota in Japan's 200-mile zone, the Government conceded more than it gained in the negotiations.

Despite these customary complaints about the "weakness" of the government's fishery diplomacy, Hokkaido fishing industry leaders seem much less worried than they did after last May's interim agreement. One reason is that the May agreement, which led to the idling of 350 Hokkaido fishing vessels, was potentially far more damaging than the current one. Another is that the industry is apparently more confident this time that emergency government loans and compensation payments will adequately cushion Hokkaido fishermen forced out of the Soviet zone.

Ironically, there are also expectations that, due largely to reduced catches in Soviet waters, fish prices will remain high enough this year to sustain the prosperity of the island's fishing industry[2].

Table 3.—Russia's 1978 quotas within the Japanese 200-mile zone (in metric tons).

Species	Okhotsk Sea	Pacific Ocean	Total quota 1978	Quota Jul.-Dec. 1977	Actual catch 1976	1978 quota as % of 1976 catch
Sardine and mackerel	—	318,000	318,000	200,000	287,000	111
Pollock	—	80,000	80,000	30,000	174,000	46
Itohikidara (Remonema)	—	138,000	138,000	58,000	138,000	100
Saury	—	20,000	20,000	10,000	n.a.	—
Sand lance	30,000	—	30,000	4,500	30,000	100
Other	3,000	61,000	64,000	32,500	36,000	178
Total	33,000	617,000	650,000	335,000	665,000	98

Source: Regional Fisheries Attache, U.S. Embassy, Tokyo.

Table 2.—Species allocated to Japanese fishermen in seven fishing areas within the Soviet 200-mile zone, 1978.

Fishing Area	Species
1. Northern Okhotsk Sea 57°30'N-58°30'N and 146°10'E-154°0'E	Snail
2. Kuriles, Pacifc side West of 155°N including the four disputed islands	Flounders, ocean perch, Wachna cod, cod, saury, octopus, squid, pollock, etc.
3. Kuriles, Okhatsk side South of 50°N including the off the coasts	Cod, pollock, flounders, squid, saury, and octopus
4. Nijo-Iwa, northern Hokkaido	Sand lance and hair crab
5. Okhotsk Sea 54°-56°N and 147°E-153°E	Brown king crab
6. East Sakhalin 45°40'-50°N and a line connecting 146°N, Cape Aniwa and Cape Kita Shiretoko.	Tanner crab and snail
45°40'N-49°0'N and a line connecting 146°10'N-Cape Aniwa and Cape Kita Shiretoko	Other fish, pollock, etc.
7. Japan Sea, Primorskaya South of a line connecting Cape Berkina and a point 12 miles south of Cape Notoro on West Sakhalin, and East of 135°E.	Other fish, pollock, squid, flounders, cod, atka mackerel
West of 135°E	Red tanner crab and squid

Source: Regional Fisheries Attache, U.S. Embassy, Tokyo.

[1]For additional information on the impact of reduced catches in the Soviet 200-mile zone, request IFR-78/4R "Fisheries in Hokkaido" from NMFS Statistics and Market News Offices.

[2]For additional information on the impact of rising prices on the Japanese fishing industry request IFR-78/16 "Major Japanese Fishing Firms Profit in 1977" from NMFS Statistics and Market News Offices.

Canada, Alaska, Russia Sea Urchin Roe Eyed

Japanese trading firms are reportedly eyeing Alaska and Canada, along with the Soviet Union, as possible additional sources of supply for fresh sea urchin roe for which an expanding consumer demand is projected at home, according to a trade journal analysis in Tokyo. Fresh sea urchin roe, a delicacy traditionally reserved for sushi bars and high-class restaurants in Japan, has recently begun to appear at retail food stores and supermarkets, and this trend is expected to strengthen in the future.

The United States and South Korea have been two major foreign suppliers of fresh sea urchin roe to Japan, and recently Mainland China and Australia have emerged as new suppliers. (Source: Foreign Fishery Information Release 78-5.)

Regional press reaction to the agreement has also been comparatively restrained. While acknowledging that the fishing industry faces formidable difficulties, newspaper commentary has conspicuously avoided describing these difficulties as a "crisis." This attitude appears to reflect a growing public perception that, contrary to earlier predictions in the press, the region's fishing industry has been enjoying unprecedented prosperity since last summer, partly at the expense of the consumer.

Fishermen, like most large processors and wholesalers, are generally seen as reaping windfall profits by taking advantage of high fish prices, generous government aid, unusually good catches in Japanese coastal waters, and extensive fish stockpiling before the implementation of the Soviet 200-mile law.

The northern Japan reaction, or lack of it, suggests that the sense of crisis engendered by the establishment of the Soviet 200-mile zone last year has now largely dissipated both among the industry and general public. Soviet fishing restrictions will continue to arouse regional concern, for example, during the upcoming salmon negotiations.

Nevertheless, there appears to be a growing feeling that the region's fishing industry can survive these restrictions in the short run, and that over the longer run the industry's viability will depend less on the probably futile effort to maintain traditional catch levels in the Soviet zone than on developing Japan's own coastal fishing resources and promoting aquaculture. (Source: International Fishing Release 78/17.)

Tuna Fishing Booms in Indian Ocean

Good tuna fishing spread over the entire Indian Ocean to include not only the traditional albacore and yellowfin fishing grounds northeast and east of Madagascar but also the Bay of Bengal and other eastern regions of the Ocean, earlier this year. Catches were reportedly ranging from an average 3 to 3.5 tons of mainly yellowfin tuna a day per vessel by South Korean vessels which reportedly numbered at least 130, to an average 1.5 to 2 tons of mainly albacore tuna a day per vessel by Taiwanese vessels which numbered nearly 100.

Yellowfin tuna was being shipped mainly to Italy at around US$1,400 a metric ton, C&F Italy, while albacore was being shipped mainly to Puerto Rico at around US$1,280 a metric ton, FOB local bases in the Indian Ocean, and at between US$1,450 and 1,500 a short ton, C&F Puerto Rico. Shipments to Japan were also reportedly on the rise.

The tuna fishing boom in the Indian Ocean started last summer and was then running into its ninth month, in contrast to the extremely poor fishing for tuna in the Atlantic Ocean, particularly for albacore in the north Atlantic, which began during the latter half of last year. (Source: Foreign Fishery Information Release 78-4.)

Norway's Sales of Dried Fish Decline

Dried fish (tørrfisk or stockfish) is one of Norway's oldest trading goods, dating back to Viking times when on their various excursions it was carried as both a source of food and a bartering good, according to Norinform, the Norwegian Information Service. Last year Norway exported about 12,000 tons of dried fish, a 35 percent drop from the previous year and mainly due to a loss of considerable parts of the Nigerian market. There was an increase in internal consumption of dried fish which was mainly used for making "lutefisk," the dried fish being treated in a lye solution. The rest of the production that had been intended for export was stockpiled and early this year stores in Norway amount to about 20,000 tons.

In 1976 the total export of dried fish amounted to about 18,400 tons worth about 415 million NOK. Nearly two-thirds of this went to Nigeria. The next largest market was Italy, taking 4,200 tons and then Sweden, Finland, and Yugoslavia. Last year, exports to Nigeria dropped to about 5,000 tons following a decision of the Nigerian authorities to put more emphasis on the import of capital goods rather than consumer goods.

The dried fish (tørrfisk) referred to above is often called "stockfish" and is quite often confused with another form of dried fish called in Norwegian "klippfisk." Tørrfisk is unsalted, air-dried cod. It is decapitated, cleaned, and hung to dry on racks. Klippfisk known often as "bacaloa" is decapitated, cleaned, and the backbone is removed. The two fillets are joined thus only in the back and when spread out, cause the dried fish to take on the characteristic triangular shape. It is strongly salted, goes through a maturing process, is re-cleaned and resalted and then dried in modern drying plants.

Japanese Firms Compete for East Coast Bluefin Tuna

Earnest competitions were reportedly under way early this year among the Japanese fishery and trading firms vying for larger shares of the U.S. and Canadian east coast bluefin tuna, so-called "jumbo bluefin tuna," which they will airlift to Japan this summer and fall.

The intense competition this year reportedly stems from the expectation that the supply of fresh east coast bluefin tuna this year will not surpass last year's level by a wide margin. Last year, competitions among the Japanese buyers drove the ex-vessel prices as high as C$7/pound. Last year's purchase by Japanese firms, totaling about 1,000 tons for 3,300 fish worth ¥1,615 million (US$6 million at ¥269=US$1), consisted of about 2,000 and 500 naturally grown fish respectively from the United States and Canada, along with about 700 corral-grown fish. (Source: Foreign Fishery Information Release 78-5.)

Canada's 1977 Atlantic Coast Landings Increase

Canada's 1977 Atlantic region fisheries catch totaled almost 900,000 t, a slight increase from 1976 (Table 1). Total ex-vessel values rose by about 14 percent, reflecting generally higher prices, especially for groundfish species like cod.

Against this background of stable landings and rising ex-vessel values, the results were uneven, depending on the species. Groundfish and shellfish landings rose appreciably, while landings of pelagic and estuarine species declined, mainly due to a decrease of 53,000 t in herrring landings. In the groundfish sector, cod and turbot accounted for practically all of the increase, while, among crustaceans and mollusks, squid landings rose by 20,000 t, almost three times the 1976 level.

Table 1.—Canadian Atlantic Coast landings, by quantity (metric tons) and value (C$1,000), in 1976 and 1977.

	1976		1977[1]	
Species	Quantity	Value	Quantity	Value
Groundfish				
Catfish	4,111	503	3,864	548
Cod	193,548	42,995	229,912	59,379
Cusk	3,218	662	3,283	732
Flounder and sole	110,369	20,385	108,629	22,874
Haddock	19,324	8,143	24,858	10,561
Hake	10,580	1,721	10,214	1,815
Halibut	1,322	2,135	1,462	2,264
Pollock	23,239	3,362	21,643	3,413
Redfish	89,652	11,445	64,534	9,485
Turbot	11,515	1,897	22,734	4,435
Other	2,777	341	3,576	377
Total	469,655	93,589	494,709	115,883
Pelagic and Estuarine				
Alewives	7,577	714	9,139	843
Capelin	9,957	323	10,507	544
Eels	604	701	628	910
Herring	225,386	15,821	172,329	18,020
Mackerel	15,756	2,083	19,202	2,148
Salmon	2,195	4,270	2,115	5,438
Smelts	2,153	591	1,806	511
Swordfish	61	97	113	207
Tuna	7,036	4,751	6,287	5,549
Other	2,237	303	2,596	681
Total	272,962	29,654	224,722	34,859
Shellfish				
Clams	2,395	987	2,843	1,042
Crabs	10,840	4,769	14,372	7,367
Lobsters	16,079	46,047	15,270	44,016
Oysters	1,112	523	917	507
Scallops	93,400	38,881	105,052	38,901
Shrimps	5,018	3,196	6,157	4,053
Squid	10,951	1,084	30,221	3,359
Other	647	162	438	109
Total	140,442	95,649	175,270	99,354
Viscera, tongues, and scales	2,646	1,311	1,876	557
Total	885,705	220,203	896,577	250,645

[1]The 1977 figures are preliminary.

Source: Canada. Ministry of Industry, Trade, and Commerce, *Statistics Canada*, Monthly Review of Canadian Fisheries Statistics, December 1977.

The overall increase of almost 14 percent in ex-vessel values to C$250 million in 1977 was due primarily to strong prices for groundfish. The total ex-vessel value for cod alone was about C$16.5 million greater than in 1976, and accounted for about 55 percent of the total increase in ex-vessel values for all Atlantic coast fisheries. Herring prices were much higher than in previous years, and despite the large decrease in landings the total ex-vessel value of the herring fishery increased by more than C$2 million. On the other hand, the general upward trend in prices did not apply to the key species in the shellfish sector. Lobster prices were stable and scallop prices declined appreciably. Both of these fisheries depend heavily on the exports to the United States. In 1977, the scallop landings increased by more than 10,000 t over 1976, thus contributing to unusually heavy supplies in the U.S. market and depressing prices.

The small increase in overall landings, considerably less than the increase in the quantity of fish landed in 1977 by U.S. New England fishermen, was not unexpected. Unusually severe winter weather in the early months of 1977 made fishing operations difficult for the smaller fishing vessels, and it was not until the end of the year that the landing figures caught up with and surpassed by a small amount the results for 1976. Moreover, the Government's conservation policies, especially as they applied to certain traditional fisheries in the Gulf of St. Lawrence and off Nova Scotia, placed severe limits on directed fishing for overexploited species. Landings of redfish and herring, for example, will take years to increase by an appreciable quantity. Haddock landings will also remain stable for some years.

The economic return of Canada's Atlantic Coast fisheries during the first year of extended jurisdiction gave more cause for optimism. Total ex-vessel values increased by C$30 million, and except for the major shellfish species, the trend was fairly widespread. Particularly encouraging was the improvement in squid and herring prices, both fisheries which the Government has made substantial efforts to modernize and help develop for export markets.

Nonetheless the economic value of Canada's Atlantic Coast fisheries remains heavily dependent on three species: cod, lobster, and scallops. The 1977 values of these three fisheries accounted for about 57 percent of total landed values for all Atlantic fisheries. This is significant because, despite the 1977 increases in cod and scallop landings, all three species are highly exploited and managed by strict conservation measures. Substantial and sustained increases in cod, scallop, and lobster landings in coming years are unlikely, with the possible exception of cod if the Canadians develop the fleet capacity to fish the cod stocks in the northern waters off northern Newfoundland and Labrador. (Source: International Fishery Release 78/48.)

Elver Sale Sets Record in Japan

A 12kg shipment of elvers into Japan early this year from Fukien Province of Mainland China set an all-time record for the import price of this product at ¥240,000/kg (US$464/pound at ¥235=US$1), C&F Haneda, Japan. This may be compared with the last year's high of ¥190,000/kg (US$365/pound) for imported elver from Mainland China. Japan's lagging domestic harvest of elvers this season has given rise to a strong buying interest for foreign elvers. Informed sources are predicting approximately 300,000 tons of elvers from domestic production this year, down about 19 percent from the 370,000 tons harvested last year. (Source: Foreign Fishery Information Release 78-4.)

Alaska Will Destroy Diseased Salmon Stocks

The Alaska Department of Fish and Game has announced a decision to destroy a diseased brood stock of king, or chinook salmon, *Oncorhynchus tshawytscha*, imported to Alaska from Washington State in 1972. Currently available scientific data indicates that the imported stock was not diseased initially, but probably became infected after contact with native sockeye salmon which had the disease. Ronald O. Skoog, Commissioner of Fish and Game, said the Department will use some of the affected fish for carefully controlled scientific studies, while the rest will be destroyed to protect native king salmon stocks. An immediate prohibition has been placed on any further releases of the affected kings.

In 1977, king salmon from the imported brood stock returning to the Mendenhall Ponds facility near Juneau were shown to be carriers of infectious hematopoietic necrosis virus (IHNV), a viral disease found in some salmonids. According to Robert S. Roys, Director of the Division of Fisheries Rehabilitation, Enhancement and Development (FRED), the problem kings were imported from the Carson National Hatchery on the Columbia River in 1972, before the Department had developed the capability to evaluate the genetic and pathological implications of salmon egg imports.

The decision to terminate the affected brood stock follows on the heels of an intensive review of the pathological, genetic, biological, and technical issues involved, and is based on the unanimous recommendation of Roys, his senior staff members, and the Regional Fisheries Supervisors in the Department's Southeastern Region.

The Department estimates that approximately 750,000 king salmon eggs and fingerlings at facilities in Petersburg and Sitka were affected and would have to be destroyed. In addition, Skoog said an interception and harvest program will be established at earlier release sites in Petersburg, Juneau, and Sitka to prevent spawning by returning adult and jack (immature male) king salmon infected by IHNV. Skoog also said that facilities where the Carson brood stock has been maintained will be disinfected to prevent future problems with the virus.

Roger S. Grischkowsky, the FRED Division pathologist, said the virus is found naturally primarily in sockeye (*Oncorhynchus nerka*), king salmon, and rainbow trout and steelhead (*Salmo gairdneri*) populations in the lower 48 states. However, he added that a 4-year study of the distribution of the virus in Alaskan salmon has shown that although IHNV may be found in nearly all natural sockeye salmon stocks, it has not been found yet in native Alaskan king salmon, rainbow trout, or steelhead stocks. Grischkowsky said that because the Carson king brood stock in Alaska has been shown to be susceptible to the virus, it poses a potential threat to the health of native king salmon.

IHNV can have serious detrimental effects on the survival of infected populations, but according to Grischkowsky it does not affect the value of commercial or sport caught fish.

The FRED Division currently is involved in a major king salmon enhancement program using native Alaskan stocks. According to Skoog, this program will continue to receive high priority. At the same time, FRED Division scientists will be evaluating disease and genetic factors continually to insure that existing natural stocks are not endangered. Skoog said similar reviews will accompany all future fish and egg transports in Alaska, and expressed the belief that, in his words: "With proper control and monitoring hatcheries will continue to make a positive and growing contribution to salmon and trout production in Alaska without jeopardizing any of our native stocks. This Department's primary responsibility is to protect and sustain our native wildlife species, and we intend to do just that. We also intend to protect valuable hatchery stocks from contamination by wild stocks."

Bristol Bay Salmon Data Goes To Alaska

The Fisheries Research Institute at the University of Washington has turned over its storehouse of information on Bristol Bay sockeye salmon to the Alaska Department of Fish and Game, that Department reports. The information, known as the Bristol Bay Data File, has been maintained by the institute for the past 6 years. Its relocation will provide Alaskan fisheries managers with faster information retrieval and greater flexibility in managing the rich sockeye salmon runs of Bristol Bay.

The Fisheries Research Institute began compiling information on Bristol Bay sockeye in 1946, when fisheries researchers began a sampling program on the adult salmon run in the Wood River system. The Alaska Department of Fish and Game began contributing information in 1960. Fisheries managers and biologists have long depended on the information files in monitoring the harvest and escapement of sockeye runs, but until 1972, when the files were put on computer tapes, retrieval of information was a lengthy process often requiring a week or more. Today, the computerized Bristol Bay file can provide biologists with escapement figures or smolt out-migration counts within

minutes. The result is increased efficiency in predicting future salmon runs and in promulgating day-to-day regulations to fully utilize the sockeye salmon resource.

The data file is composed of nine parts, including daily catch and escapement figures, tower and aerial escapement counts, outside, inside and offshore test fishing data, fishing period regulations, age and sex composition of both catch and escapement, and an overall summary of seasonal performance. The Bristol Bay Data File has been placed under the direction of Fish and Game research biologist Henry Yuen in Anchorage. The actual tapes will be stored at the University of Alaska in Fairbanks. Yuen said data in the Bristol Bay files is available to anyone who desires detailed information on the sockeye salmon runs of Bristol Bay.

Texas Gulf Crabbing Hits All-Time High

Crabbers hauled in an all-time record catch of blue crabs on the Texas Gulf Coast during 1977, exceeding the previous high catch by more than a million pounds. The 1977 catch by commercial fishermen, compiled by the Texas Parks and Wildlife Department, was 8,150,384 pounds. The record had been 1973's total of 6,881,137 pounds.

This increased attention to the blue crab as a commercial species has prompted the department to start surveys to learn more about them. During 1977, crab trap surveys were initiated in several Texas bays to determine fishing pressure. Another survey is underway in the Galveston Bay system, with tags placed on the backs of a number of mature crabs in an attempt to learn more about their winter movements.

Fishermen who find these tagged crabs are asked to deliver the tag to one of the following: 1) the department office at Box 8, Seabrook, Tex., phone (713) 474-2811; 2) any commercial crab dealer on the Galveston Bay system; or 3) any Parks and Wildlife Department office or employee, including your name, address, when and where caught, and the capture method. The round tags are attached to the crabs' backs with wire.

There are two species of blue crab on the Texas coast, but one of them, the lesser blue crab, is too small to be of commercial value. Biologists believe the increased crabbing may be due to several factors, including good prices, harsh weather in traditional crabbing areas in the northeastern states, and natural development of a hitherto underutilized resource.

New Marine Resource Committee Is Formed

A new Committee on Marine and Estuarine Resources has been formed by the Southern Division of the American Fisheries Society, reports Committee Chairman Charles Manooch, III. The major objectives of the Committee are to 1) Create a general interest and awareness of marine and estuarine fisheries related work among AFS Southern Division members and, conversely, create an active participation in the Southern Division by marine and estuarine fisheries workers; 2) Provide a more uniform effort among fisheries workers throughout the Division to resolve problems which are common to both freshwater and marine regimes; discuss research and/or monitoring programs to address shared and unique problems; and 3) Strive to educate recreational fishermen in the area of management of estuarine and marine fisheries.

Persons interested in discussing these or other topic areas may contact the Committee Chairman Charles Manooch, III, Southeast Fisheries Center Beaufort Laboratory, National Marine Fisheries Service, NOAA, P.O. Box 570, Beaufort, N.C. 28516. The Committee also plans to publish the marine and estuarine papers that are presented at each annual meeting. For information concerning the presentation of papers contact: John Grover, Dept. of Fisheries and Allied Aquacultures, Auburn University, Auburn, AL 36830.

MARYLAND PREDICTS GOOD CRAB SEASON

A good year for Maryland crabbers is predicted by the Department of Natural Resources for the crab season which began 1 April and extends until 31 December. Ray C. Dintaman, Chief crab biologist with DNR's Fisheries Administration was hesitant to pin down specific figures, but said: "On the basis of a good 1976 hatch and preliminary evidence of a good 1977 hatch, we look for a better harvest in Maryland than we've had for the past two seasons."

The 1976 commercial harvest was 20.9 million pounds and the 1977 total was 19.2 million. Dintaman regards those years as normal fluctuations from the Maryland average of 25 million pounds.

A new reporting system for the crab catch will be inaugurated this year, Dintaman said, in an effort to obtain more accurate figures on the total crab catch. In the past, the figures reflected only those crabs which were processed in packing houses. They did not include the so-called "basket trade," Dintaman said, those crabs which go directly to market and crab houses where they are sold live or steamed.

Here's how the new system will work: New report forms have been prepared and mailed to crabbers. This year, only the state's 1,500 commercial crab potters will be required to use the new forms, but next season, Dintaman hopes all commercial crabbers will be using the new system.

Crab potters will record their catch daily and mail the forms to the Fisheries Administration at the end of the month. "I hope the system will give us a more complete picture of Maryland's crabbing industry," Dintaman said. He said he hoped it will disclose such information as: 1) The poundage caught per pot each day; 2) Areas of good and poor harvest, because the form provides a place to record the waters where the pots were set each day; 3) Final disposition of crabs landed. In addition to the good hatches, Mr. Dintaman said mortality of crabs over the winter appeared to be low.

NMFS Scientific Reports Published

NOAA Technical Report NMFS SSRF-714. Nelson, Craig S. **"Wind stress and wind stress curl over the California Current."** August 1977. 87 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

ABSTRACT

Historical surface marine wind observations are summarized by 1-degree square areas and months to describe the seasonal distribution of wind stress over the California Current. Off the coasts of southern California and Baja California, an alongshore equatorward component of surface wind stress is present throughout the year. The distributions of wind stress north of Cape Mendocino are characterized by marked changes in direction and magnitude between summer and winter. The predominant wind stress maximum shifts northward coherently from off Point Conception in March to south of Cape Blanco in September, and extends approximately 500 km in the offshore direction and 1,000 km in the alongshore direction. Maximum values of surface wind stress occur during July near Cape Mendocino. The wind stress curl is positive near the coast and negative in the region offshore. A line of zero wind stress curl parallels the coast 200-300 km offshore, except off central Baja California. The patterns of wind stress curl are consistent with the existence of an equatorward Sverdrup transport offshore and a poleward transport near the coast.

NOAA Technical Report NMFS SSRF-713. Straty, Richard R. **"Current patterns and distribution of river waters in inner Bristol Bay, Alaska."** June 1977. 13 p.

ABSTRACT

Hydrographic studies to determine the distribution of the waters of the major sockeye-salmon-producing river systems in inner Bristol Bay show the net seaward flow of river water is along the northwest (right) side of inner Bristol Bay. The net motion of seawater toward the head of Bristol Bay transports with it the waters of Ugashik and Egegik rivers, which enter the bay on the southeast side. Near Egegik Bay to Middle Bluff, the mixed sea and river waters join the seaward flow of Kvichak and Naknek river waters, which enter at the head of Bristol Bay. Waters of these four rivers, along with the large volume of water from the rivers entering Nushagak Bay, are eventually transported to, and move seaward on, the northwest side of Bristol Bay. Waters of Naknek, Egegik, and Ugashik rivers are similar to each other in the courses followed during ebb and flood tides. Flood tide currents, along with the nontidal current, transport water from Egegik and Ugashik rivers above or north of the entrance to Egegik and Ugashik bays.

Marine Oil Pollution Literature Referenced

A processed report, "Subject Classified Literature References on Effects of Oil Pollution in Arctic and Subarctic Waters," has been compiled by Maurice E. Stansby and Isabel Diamant, of the NMFS Northwest and Alaska Fisheries Center. This 201-page report lists references under 20 subject categories such as effects of oil under ice and snow, effects on physiological processes, weathering of oil, and taint as a flavor in fish from oil pickup. Copies may be requested from Maurice E. Stansby, Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Boulevard East, Seattle, WA 98112.

DIATOM BIOLOGY IS EXAMINED

Publication of "The Biology of Diatoms" (Botanical Monographs, Volume 13) has been announced by the University of California Press. Authored by several practicing biologists, the book reviews aspects of diatom biology and describes results of recent research. It was edited by Dietrich Werner, Professor at the Botanisches Institut, Universitat Marburg-L, Germany. Chapters discuss diatom growth and culture, ultrastructure of the diatom cell, silicate metabolism, photosynthesis, heterotrophic nutrition, biochemical composition, movements, sexuality, freshwater diatom ecology, ecological considerations of marine littoral diatoms, and ecology of marine planktonic diatoms. The 505-page indexed volume is available for $32.50 from the University of California Press, 2223 Fulton Street, Berkeley, CA 94720.

Eels, Their Capture, and Uses Outlined

"Eels, A Natural and Unnatural History," by Christopher Moriarty, has been released by Universe Books, 381 Park Ave. South, New York, NY 10016. The author is assistant inspector of fisheries for Ireland's Department of Agriculture and Fisheries and has studied and worked with eels since 1959.

This book examines eel lore and legend, basic eel biology and migrations, the catching and farming of eels, getting eels to the consumer and eel cooking, and eel classification. Appendices describe length distribution of eels, age distribution, food preferences and a list of food organisms found in

eels. An index and list of references are provided. The hardbound, small-format book has 192 pages, costs $15.00, and is available from the publisher.

Mexican EEZ Impact on Shrimping; Freshwater Shrimp Diseases Eyed

The expected economic impact of the 200-mile extended jurisdiction limit by Mexico on the U.S. shrimp fleet is explored in **"Mexico's 200-Mile Offshore Fishing Zone: Its Economic Impact on the U.S. Gulf of Mexico Shrimp Fishery"** (TAMU-SG-77-210), by Wade L. Griffin and Bruce R. Beattie.

The 35-page Texas A&M University report estimates average annual shrimp catch and effort expended by the U.S. fleet in Mexican waters. Also, economic effect on the U.S. shrimp fishery due to shifting the effort from Mexican waters to U.S. waters is estimated in terms of rent loss to the fishery and break-even product prices required to achieve open-access equilibrium.

"Crawfish and Freshwater Shrimp Diseases" (TAMU-SG-77-605), by S. K. Johnson, is designed as an information source and field guide for crustacean culturists, commercial fishermen, and others interested in parasites or abnormal conditions of freshwater crustaceans.

Detailed descriptions, photographs, and illustrations of the common parasites and commensals are given along with information on their life cycles and general biological characteristics in the 20-page handbook. Several diseases of unknown cause are also described. A list giving definitions of terms is included, as are 18 color photos, 30 black-and-white photos, and 10 illustrations. There is no charge for single copies but $2.00 per copy is charged for orders of from 2 to 10 copies. For larger orders, write for prices.

Both publications are available from the Sea Grant Program, Center for Marine Resources, Texas A&M University, College Station, TX 77843. Make checks payable to "Texas A&M University."

Other Texas A&M University publications in print are "Stop Shrimp 'Black Spot'" by Ranzell Nickelson II and Bruce Cox (TAMU-SG-77-504), a 4-page advisory bulletin "Freezing Fish and Shellfish" by Ranzell Nickelson and Sally Springer (TAMU-SG-77-503); "Seafood Retailing" (second edition) by Samuel M. Gillespie and William B. Schwartz (TAMU-SG-77-401); and "Bottom Fishing Obstructions: Texas/Louisiana Gulf" by Gary L. Graham (TAMU-SG-76-502).

Joint Soviet-Japan Aquaculture Symposia Proceedings Printed

The proceedings of the Second, Third, Fourth, and Fifth Soviet-Japan Joint Symposia on Aquaculture have been published as a four-volume set by Tokai University, Japan. Each volume contains the papers presented by Soviet and Japanese scientists at one of the annual meetings as well as information on the general program each year. Many of the actual texts are in Russian or Japanese and abstracts in English only accompany the Japanese texts. Information on the contents of these volumes and the previously published proceedings of the First Joint Symposium can be obtained from NMFS Statistics and Market News Offices by sending a self-addressed mailing label and requesting a copy of IFR 78/36.

The symposia were held alternately in the Soviet Union and Japan under the sponsorship of the Russian All-Union Scientific Research Institute of Fisheries and Oceanography (VNIRO) and Japan's Tokai University. The first symposium was held in Tokyo and Shimizu in December 1972; the second in Moscow in November 1973; the third in Tokyo in November 1974; and the fifth in Tokyo and Sapporo in September 1976. The sixth symposium proceedings, not yet published, was held in Moscow and Batumi in October 1977.

Additional information on the published symposia and ordering instruction can be obtained from M. Ikematsu, Faculty of Marine Science and Technology, Tokai University, 1000, Orido, Shimizu (424), Japan.

A Forum on Water Resource Problems

The quarterly magazine *Water Spectrum*, published by the Corps of Engineers, Department of the Army, presents a broad range of opinion on water resources issues. Written for both the professional and the interested lay person by experts in the field, recent articles have covered nonpoint pollution, river quality assessment, vanishing plants and animals, nonstructural flood control, the canal system of Finland, flood insurance, the return of the bald eagle, drought, and more.

Water Spectrum is offering a free copy of its latest issue to prospective subscribers. Write the Editor, *Water Spectrum*, Office, Chief of Engineers, Department of the Army, Washington, DC 20314.

EUROPEAN MARINE FISHING REVIEWED

"Fisheries of the European Community," has been published by the White Fish Authority's Fishery Economics Research Unit. The 16-page large format booklet contains a statistical survey of EC fisheries, updating the data published in the last issue of "Fish Industry Review" in mid-1975, and includes new material on the industries of three EC-applicant countries, Greece, Spain, and Portugal.

The EC's common fisheries policy is reviewed by E. Gallagher, EC Director General for Fisheries, and contributions on fisheries from the national standpoints of Ireland, Belgium, France, Netherlands, United Kingdom, and Denmark are presented. The booklet costs £2 and is available from the White Fish Authority, Sea Fisheries House, 10 Young Street, Edinburgh, Scotland EH2 4JQ.

Meetings, Manatees, and a Razor Clam Transplant

. . . . **The Third International Congress on the History of Oceanography** will be held at Woods Hole, Mass., 22-26 September 1980. It will be followed a week later (29 Sept.-4 Oct.) by an Assembly on current and future oceanography. Expressions of interest in the Congress, particularly from those who plan to contribute papers on any aspect of the History of Oceanography, will be welcomed, as soon as possible, by Daniel Marriman, Professor Emeritus of Biology, Yale University whose address is: 298 Sperry Road, Bethany, CN 06525 . . . .

. . . . **An International Conference on Fish Science & Technology** will be held in Aberdeen, Scotland, 23-27 July 1979, in connection with the 50th Anniversary of the establishment of the Torry Research Station. The conference will 1) review the state of advancement in various areas of fish science and technology, and 2) provide a forum for the presentation of the latest findings in research and development. A detailed brochure and application forms will be available from the Torry Research Station, P.O. Box 31, 135 Abbey Road, Aberdeen, AB9 8DG later this year . . . .

. . . . **Manatee sightings in South Carolina last summer** support the theory that the state may have a summer population of the rare animal, the Wildlife and Marine Resources Department reports. Biologists there believe the manatee, or "sea cow," migrated up the coast from Florida, perhaps as far as North Carolina. "We've had historic reports of manatees in South Carolina," said biologist Ken Stansell, a member of the Manatee Recovery Team, but "these are the first confirmed sightings that we've had in several years." Classed as an endangered species, less than 1,200 manatees are believed to be in Florida waters . . . .

. . . . Meanwhile, the Florida Department of Natural Resources has been **erecting "Manatee Crossing" signs in four areas** where the slow-moving creatures winter—Orange River, Crystal River, Blue Spring, and Titusville. Similar signs may be placed in 20 other areas to alert boaters. About 25 percent of all manatees found dead reportedly die from collisions with boats . . . .

. . . . **More than 1,000,000 juvenile razor clams were transplanted** from Washington State's Roosevelt Beach to the Grayland Beach area late last year, the Department of Fisheries reports. Shellfish biologists noted concentrations of up to 600 of the ⅛- to ½-inch clams per square foot in the Roosevelt Beach area, but none in the Grayland Beach area. The top 2-inch layer of sand (and clams) was placed in boxes for the move. A similar transplant in 1966 put an estimated 1 million razor clams in the Grayland Beach area . . . .

. . . . **Confirmation of a late redfish spawn** in Texas' Port Isabel area may indicate that help is on the way for declining populations of this popular marine game fish, the Parks and Wildlife Department reports. Department fisheries biologists seined a number of juvenile redfish in the Lower Laguna Madre in mid-January which averaged 0.6 inch long. Normally, Texas' redfish spawn in late summer or early fall and would be about 3 inches long by that time . . . .

. . . . **New Jersey lobster populations will benefit** from a new law enforcement technique for identifying female lobsters from which eggs have been illegally removed, the Division of Fish, Game and Shellfish reports. The eggs are attached by a cement to hair-like structures on the swimmerets of the lobsters and, if forcibly removed, some of the cement will remain. Using a staining technique, officers can detect the cement and thus have proof of illegal action. Special field kits have been designed for such tests which have been used in successful prosecutions in Rhode Island . . . .

. . . . There is a good chance that **more Louisiana eels may go to international markets,** the Department of Wildlife and Fisheries reports. Eel dealers have been visiting the state seeking supplies for Dutch, Danish, French, German, Italian, and Japanese markets where the species is considered a gourmet item. Because the eel fishery is so new to the state, the department wants to supervise it carefully from the start. As fishing techniques are being worked out and markets established, Louisiana eel fishermen and dealers are being required to furnish monthly reports related to the catch . . . .

. . . . **The popularity of the land hermit crab,** *Coenobita clypeatus,* as a house pet appears to be on the decline, the Florida Department of Natural Resources reports, citing NMFS statistics showing that imports have decreased from 208,000 last November to 61,000 in January. "Retail sale of these animals probably peaked during the Christmas season," said Charles Futch, assistant bureau chief of Marine Science and Technology. Most hermit crabs entering commerce were imported from Panama, Haiti, and Costa Rica, but a few were still being collected in the Florida Keys . . . .

. . . . **South Carolina's commercial catch of snappers, groupers,** and associated species more than doubled during 1977 to exceed 700,000 pounds, worth more than $500,000, according to the Wildlife and Marine Resources Department. Most were taken by Florida-based boats which continued a growing trend to land their catch in South Carolina. Only a few South Carolina boats have attemped the Florida-style snapper/grouper hook and line fishery in which electric reels are used . . . .

Editorial Guidelines for *Marine Fisheries Review*

Marine Fisheries Review publishes review articles, original research reports, significant progress reports, technical notes, and news articles on fisheries science, engineering, and economics, commercial and recreational fisheries, marine mammal studies, aquaculture, and U.S. and foreign fisheries developments. Emphasis, however, is on in-depth review articles and practical or applied aspects of marine fisheries rather than pure research.

Preferred paper length ranges from 4 to 12 printed pages (about 10-40 manuscript pages), although shorter and longer papers are sometimes accepted. Papers are normally printed within 4-6 months of acceptance. Publication is hastened when manuscripts conform to the following recommended guidelines.

The Manuscript

Submission of a manuscript to *Marine Fisheries Review* implies that the manuscript is the author's own work, has not been submitted for publication elsewhere, and is ready for publication as submitted. Commerce Department personnel should submit papers under completed NOAA Form 25-700.

Manuscripts must be typed (double-spaced) on high-quality white bond paper and submitted with two duplicate (but not carbon) copies. The complete manuscript normally includes a title page, a short abstract (if needed), text, literature citations, tables, figure legends, footnotes, and the figures. The title page should carry the title and the name, department, institution or other affiliation, and complete address (plus current address if different) of the author(s). Manuscript pages should be numbered and have 1½-inch margins on all sides. Running heads are not used. An "Acknowledgments" section, if needed, may be placed at the end of the text. Use of appendices is discouraged.

Abstract and Headings

Keep titles, heading, subheadings, and the abstract short and clear. Abstracts should be short (one-half page or less) and double-spaced. Paper titles should be no longer than 60 characters; a four- to five-word (40 to 45 characters) title is ideal. Use heads sparingly, if at all. Heads should contain only 2-5 words; do not stack heads of different sizes.

Style

In style, *Marine Fisheries Review* follows the "U.S. Government Printing Office Style Manual." Fish names follow the American Fisheries Society's Special Publication No. 6, "A List of Common and Scientific Names of Fishes from the United States and Canada," third edition, 1970. The "Merriam-Webster Third New International Dictionary" is used as the authority for correct spelling and word division. Only journal titles and scientific names (genera and species) should be italicized (underscored). Dates should be written as 3 November 1976. In text, literature is cited as Lynn and Reid (1968) or as (Lynn and Reid, 1968). Common abbreviations and symbols such as mm, m, g, ml, mg, and °C (without periods) may be used with numerals. Measurements are preferred in metric units; other equivalent units (i.e., fathoms, °F) may also be listed in parentheses.

Tables and Footnotes

Tables and footnotes should be typed separately and double-spaced. Tables should be numbered and referenced in text. Table headings and format should be consistent; do not use vertical rules.

Literature Citations

Title the list of references "Literature Citations" and include only published works or those actually in press. Citations must contain the complete title of the work, inclusive pagination, full journal title, the year and month and volume and issue numbers of the publication. Unpublished reports or manuscripts and personal communications must be footnoted. Include the title, author, pagination of the manuscript or report, and the address where it is on file. For personal communications, list the name, affiliation, and address of the communicator.

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Authors must double-check all literature cited; they alone are responsible for its accuracy.

Figures

All figures should be clearly identified with the author's name and figure number, if used. Figure legends should be brief and a copy may be taped to the back of the figure. Figures may or may not be numbered. Do not write on the back of photographs. Photographs should be black and white, 8- × 10- inches, sharply focused glossies of strong contrast. Potential cover photos are welcome but their return cannot be guaranteed. Magnification listed for photomicrographs must match the figure submitted (a scale bar may be preferred).

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Finally

First-rate, professional papers are neat, accurate, and complete. Authors should proofread the manuscript for typographical errors and double-check its contents and appearance before submission. Mail the manuscript flat, first-class mail, to: Editor, *Marine Fisheries Review*, Scientific Publications Office, National Marine Fisheries Service, NOAA, 1107 N.E. 45th Street, Room 450, Seattle, WA 98105.

The senior author will receive 50 reprints (no cover) of his paper free of charge and 100 free copies are supplied to his organization. Cost estimates for additional reprints can be supplied upon request.

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